Volume 15 Number 1 Winter 1985

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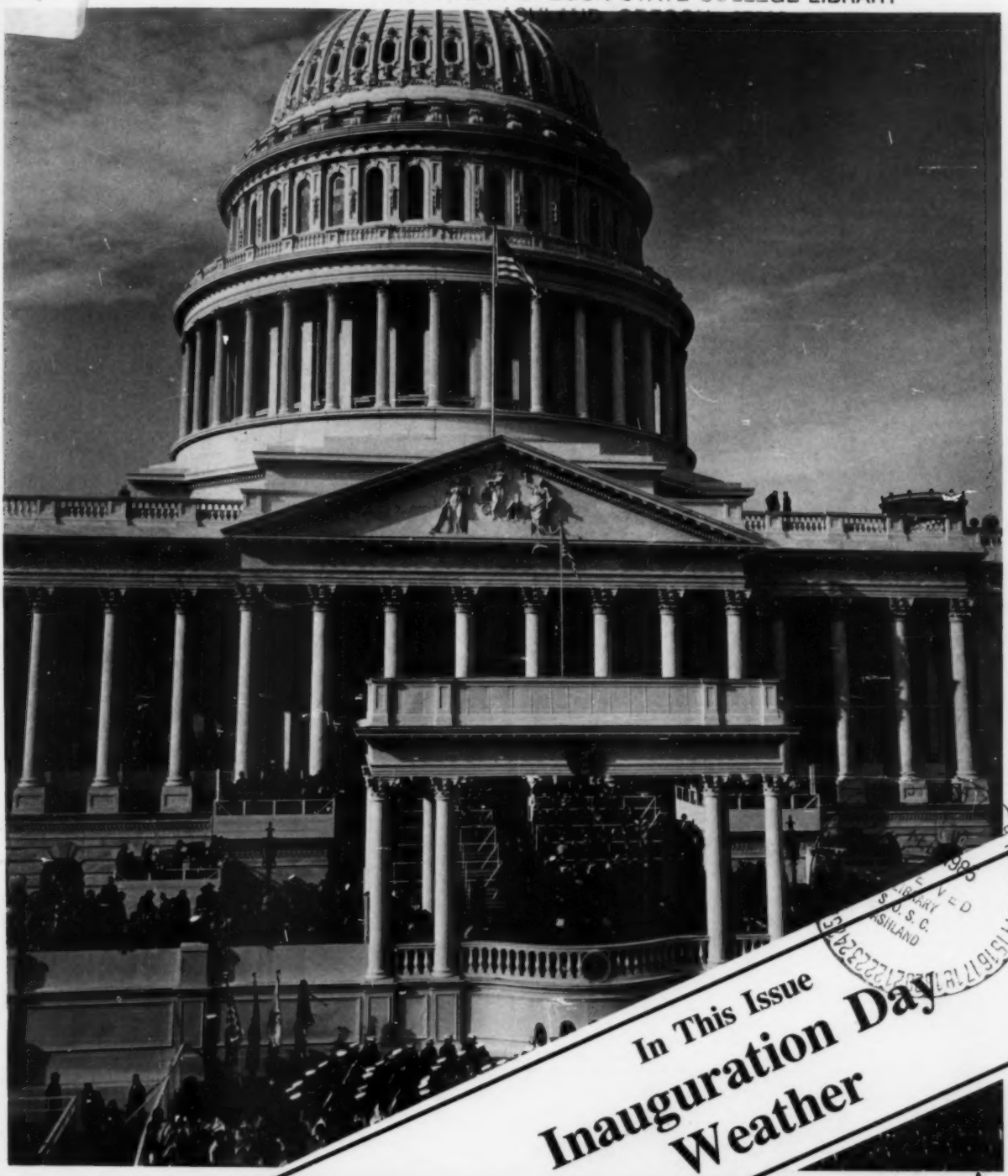

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U.S. DEPARTMENT OF COMMERCE
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DEPOSITORY

Newsline

Is Global Warming On The Way?

NOAA has launched a study of atmospheric gases that act like a greenhouse above the earth, trapping the sun's heat and having the potential to warm the global climate. Daniel L. Albritton, of the Environmental Research Laboratories, said atmospheric concentrations of trace gases — chlorofluorocarbons, nitrous oxide, methane, and tropospheric ozone — appear to be increasing. Combined, he said, they could cause a global warming equivalent to that expected from carbon dioxide. NOAA's research initially will center on the development of instruments, and techniques for monitoring and measuring the concentrations of the various trace gases. Scientists will also create computer programs to assess possible climate changes.

Buoys Dropped In Hurricane Work Well

Hurricane research took a new twist in the 1984 season when three NOAA satellite-reporting buoys were airdropped in the path of Hurricane Josephine, off Grand Bahama Island, vividly showing ocean changes during the passage of a major storm. The drop, according to NOAA researcher Peter Black, provided new information on winds, atmospheric pressure, and subsurface temperatures. Confirmation of its accuracy came when NOAA research aircraft recorded identical pressures in Josephine's eye as those recorded by the buoys far below in the storm's eye. The experiment was designed to improve understanding of storm surge.

NOAA, D.C. Schools Join In Project

NOAA and the District of Columbia Public Schools have become partners in education. Under a White House-sponsored program, NOAA volunteers are working with D.C. elementary and middle school students and teachers, providing lectures, tutoring, presentations, and tours covering most of NOAA's disciplines. The Partners In Education project is a joint effort of government agencies, private businesses, and public school systems matching knowledge and skills of employees with needs of students and teachers. More than 40,000 schools have become partners.

New Boundary On Georges Bank

A compromise North Atlantic boundary line, dividing Georges Bank and its rich resources between the U.S. and Canada, has been drawn by the International Court of Justice. For the first time, it gives part of the Bank of Canada but most of the area, source of more than $150 million worth of fish for both nations in 1981, goes to the United States. The United States had argued that it was entitled to retain all of Georges Bank; Canada asked that it be divided roughly in half. The Court split the difference, setting a line about midway between the two claims. The new boundary is expected to make Atlantic fishery management much more complex than in the past, according to the National Marine Fisheries Service.

Research Habitat Planned For NOAA

Still more than a year away, but definitely in the wings, is a new, advanced temperate-water undersea research habitat for NOAA. It will be 40 feet long and 9 feet wide, with two interior chambers and a "wet porch" providing entrance to the sea. Accommodating six aquanauts, it will include a marine laboratory with a dry lab as well. Computers will monitor safety and living conditions for scientists doing on-the-spot biological and geological research. Initially, it will serve as base for 12 to 16 10–day missions annually, although it is designed to support teams for up to 30 days. It will be located in 90 feet of water off California's Santa Catalina Island, and will be operated by the University of Southern California as part of NOAA's National Undersea Research Program.

Fish Eater? You're A Winner

Do you eat more fish than most people? If so, take a bow. Marketing studies show the typical American fish eater is better educated, more citified, and has more money in his pocket than the average consumer. The National Marine Fisheries Service and the Canadian Department of Fisheries and Oceans collaborated on a study recording the eating habits of 7,500 U.S. households—including when and how they served seafood at home, and when they ordered it out. It found the average consumer eats seafood only 2–1/2 times a month and is skittish about trying new recipes, something the organizations will try to change. And oh yes, the heavy seafood eaters also tend to have fewer children than their meat-eating counterparts.

NOS Command Changes Formalized

Command of NOAA's research fleet has passed to Rear Admiral Charles K. Townsend, until recently Director of the Pacific Marine Center, from Rear Admiral Robert C. Munson, who retired Dec. 1 after 33 years' service. Succeeding Adm. Townsend at the Pacific Marine Center is Rear Admiral Robert L. Sandquist, most recently PMC Deputy Director. Meanwhile, Rear Admiral John D. Bossler, Director of Charting and Geodetic Services in the National Ocean Service, has become the first geodesist to be elected chairman of the U.S. national committee for participation in the International Union of Geodesy and Geophysics. Adm. Bossler is also president-elect of the American Congress on Surveying and Mapping, and of the Geodesy Section of the American Geophysical Union.

Hot Springs Found On Atlantic Floor

NOAA researchers have identified three new Atlantic Ocean sites of mineral-rich hot springs, in a slow-spreading area 500 to 1000 miles south of the mid-Atlantic Ridge, where a site was discovered in 1983. Dr. Peter Rona, of the Atlantic Oceanographic and Meteorological Laboratory, estimates that there may be at least 20,000 miles of slow-spreading ridges in the world's oceans, and says they may have an impact on ocean chemistry. Also engaged in the project: scientists from Cambridge University, Florida Institute of Technology, Woods Hole Oceanographic Institution, and Rutgers University.

NOAA, USDA Plan Extension Cooperation

NOAA and the Agriculture Department's Extension Service will cooperate in extension programs, under an agreement signed by the two organizations in November. NOAA and the Extension Service will plan educational and technology transfer programs to disseminate information through the State Cooperative Extension Services, develop educational materials, and conduct staff and professional improvement programs. The memorandum of understanding was signed by NOAA Administrator John V. Byrne, Mary Greenwood, Extension Service Administrator.

FEB 1985

Inauguration Day Weather

Patrick Hughes

On Inauguration Day, January 21, 1985, Ronald W. Reagan will be sworn in as 40th President of the United States. Inaugural organizers will fret right up to the last minute about the weather during the outdoor ceremony on the steps of the Capitol in Washington, D.C., but to date from NOAA's National Climatic Data Center, the President and those assembled should enjoy a cool, breezy day with some sunshine. Precipitation is unlikely.

That's if things are normal.

Before 1937 "normal" referred to the early spring weather one might expect on March 4 in Washington. Many times that meant rain or snow—often in copious quantities. In fact one out of every three inaugurations held on March 4 was notable for wet weather. The Congress put an end to this dismal record by passing the 20th Amendment which changed the date for inaugurations from March 4 to January 20. Weatherwise, the change means considerably less chance of rain or snow, though it favors lower temperatures. Bearing this out, of the 11 inaugurations held since 1937, only two—those of Franklin D. Roosevelt and John F. Kennedy—were marred by significant precipitation.

Because January 20 falls on a Sunday this year, the inaugural ceremonies will be held on Monday, January 21. (Ronald Reagan will also be sworn in Sunday at a private ceremony, to ensure continuity, since his first term will expire at noon on that date.)

Weatherwise, of course, there is little difference between the 20 and 21. Even though the coldest time of the year in Washington comes during late January and early February, temperatures on January 21 are usually not severe. The normal high temperature for the day is 44 degrees, the low, 29 degrees. The highest temperature on record is 70 degrees, in 1951; the lowest, 9 degrees, in 1920. If it does rain or snow in Washington, D.C., on January 21, the odds are that it will do little more than wet the pavement.

Average weather conditions for noon, when the President-elect is usually sworn in, would be a temperature of about 38 degrees, a northwest wind of 12 miles-per-hour, and partly cloudy skies. Chances of precipitation during the swearing-in ceremony itself are about 1 in 4, and of snow, sleet, or freezing rain or drizzle about 1 in 13.

Of course, it will rain or snow on occasion, and January temperatures and winds often make standing outdoors for several hours a chilling experience. This certainly was true of the inaugurations of Richard Nixon and Jimmy Carter. President Reagan, however, was luckier. On his first Inauguration Day, temperatures were in the 50's, almost balmy weather for January.

But such good fortune was not the lot of many former presidents.

Franklin Delano Roosevelt's second inauguration was almost washed away by the heaviest rainfall in the event's history.

Two hundred thousand visitors came to Washington for the cermemonies. Several thousand got no further than Union Station, marooned by slanting, soaking sheets of wind-driven water.

It was a wet, raw, miserable day, with temperatures hovering just above freezing. As he rode from the White House to the Capitol for the swearing-in ceremonies, Roosevelt repeatedly leaned out the window of his limousine to wave to umbrellaed knots of people clustered like black mushrooms along Pennsylvania Avenue.

Undaunted by the cold, driving rain, thousands more had massed in front of the Capitol to witness the inaugural oath. On the inaugural platform, attendants dumped puddles of water from chairs as Cabinet members and Supreme Court justices waded down a waterlogged red carpet to their wet seats. Icy torrents blowing in under the roof bathed Congressmen, government officials, and guests alike as Eleanor Roosevelt raced back and forth, bringing blankets to family and friends.

The head of the Inaugural Committee tried to talk Roosevelt into taking his oath indoors but he refused, replying "If they can take it, I can take it," and led Vice President-elect John Nance Garner out to the inaugural stand. The shivering, soggy crowd burst into cheers as Roosevelt was sworn in at 12:39 p.m., his right hand resting on the cellophane-wrapped old Dutch Bible of Claes Martenzen van Roosevelt. The rain beat steadily on the President's face all during the inaugural address, and several times he had to pause to wipe the water off.

Roosevelt insisted on an open car for the return ride to the White House. The thoroughly soaked President and First Lady rode the mile to the Executive Mansion laughing and waving to the crowds, which responded in kind. Later, Roosevelt spent another hour and a half watching the inaugural parade splash by from a specially constructed reviewing stand, an $11,000 model of Andrew Jackson's home, the Hermitage; he even had the bulletproof windows removed, the better to be seen and rained on.

"The worst weather on the face of the earth," was what one eyewitness Congressman called the snowstorm that nearly buried the inauguration of William Howard Taft in 1909.

Heavy snow began the evening before and continued through the night, driven by a stinging, whistling wind. Branches and telegraph and telephone lines snapped under the weight of the wet, clinging snow, while the wind toppled trees and poles. Pedestrians were quickly driven indoors, and carriages and streetcars stalled as nearly 10 inches of snow piled into wind-driven drifts that buried the deserted streets of the Nation's Capital.

Six thousand shovelers struggled vainly through the night and forenoon to clear the areas in front of the White House and Capitol and the route between. As noon approached, light snow was still falling, the temperature was near freezing, and the wind howled on unabated. People stood huddled in doorways or peeped out at an arctic landscape through snow-streaked windows. Postponing his decision until the last

moment, Taft finally decided to take his oath of office in the Senate Chamber, rather than on the outdoor platform erected in front of the Capitol. Ironically, the snow stopped just a few minutes later, and despite the icy, piercing wind, people began lining Pennsylvania Avenue for the inaugural parade.

Some 20,000 marchers sloshed past the snow-covered stands flanking the parade route. The wind howled through their ranks, playing particular havoc with the high-hatted representatives of various political clubs, while decorations and bunting whipped about in wind-torn shreds or sagged sadly under heavy burdens of snow. Quipped President Taft to a reporter: "I always knew it would be a cold day when I got to be President."

It was even colder on Ulysses S. Grant's second Inauguration Day in 1873; it was, in fact, the coldest Inauguration Day on record.

When cannon-fire announced the dawn, the temperature was four degrees above zero; by noon it had risen to only 16 degrees. Throughout the day, strong, gusty winds buffeted Washington—bitterly cold blasts that knifed through the heaviest clothing and chilled to the marrow all who ventured outdoors. Despite the cold and wind, large crowds filled the streets. Heavy clothing and earmuffs were the uniform of the day, except for the West Point cadets and Annapolis midshipmen who were scheduled to parade without overcoats.

When President Grant delivered his inaugural address, the wind made his words unintelligible to all but those next to him. Meanwhile, a number of the lightly dressed cadets and midshipmen, who had to stand on the windswept Mall for more than an hour and a half, lost consciousness and collapsed; several were reported "frozen."

It was almost as cold at the inaugural ball that night, held in a $40,000 temporary building erected on Judiciary Square. The contractor had neglected to install heating equipment. It was so cold that turkeys had to be cut with hatchets, and 3,000 guests danced in their overcoats and heavy wraps. When the President left just after midnight, so did everyone else.

It has been reported that Harry S. Truman, upon receiving the official invitation to his second inauguration, wrote across it in reply, "Weather permitting, I hope to be present—HST." If so, Truman, a student of history, was paying Presidential tribute to one of the more durable of American traditions—bad weather on Inauguration Day.

There is more than a little historical support for Truman's respect for Inauguration Day weather.

The weather was pleasant for the first seven inaugurations—all held indoors (although George Washington took his first oath of office on the balcony of Federal Hall in New York City)—but turned sour soon after the ceremonies were moved outdoors.

Tradition has it that the First Congress chose March 4 as Inauguration Day out of respect for the Sabbath, because it is the date that quadrennially falls least fre-

Thoroughly soaked by Inauguration Day rainfall, FDR and the First Lady manage to smile as they ride back to the White House in the open car Roosevelt insisted on. (Washington Star-News photo)

quently on Sunday. All but the first three inaugurations took place in Washington. The first was held in New York City in 1789, the second and third in Philadelphia, in 1793 and 1797, respectively, before the Nation's Capital was moved to the new Federal City in 1800. The first outdoor inauguration was James Monroe's, held in Washington on March 4, 1817. Almost as if to lull participants into a false sense of security, the weather was mild and sunny, with not a cloud in the sky.

Bad weather struck the very next inauguration, Monroe's second, in 1821. For the first time, Inauguration Day fell on a Sunday, and the ceremonies were postponed until Monday. According to the *National Intelligencer*, a "good deal" of rain and snow fell during the night. John Quincy Adams, a student of weather (as were George Washington, Benjamin Franklin, and Thomas Jefferson), recorded rain for Sunday and snow for Monday, with a chilling Inauguration Day noon temperature of 28 degrees.

The precipitation forced Monroe to change his plans for an outdoor ceremony and to take his oath of office in the House Chamber. An "immense crowd" of subdued spectators in soggy clothing thronged the Gallery to witness the swearing-in.

John Quincy Adams succeeded Monroe as President. On Adams' Inauguration Day, in 1825, it rained—the weather observation again being recorded by Adams. And again, the ceremonies had to be held indoors.

The first American President to die in office was a victim of his disdain for Inauguration Day weather.

At 68, William Henry Harrison was the last President born (1773) before the American Revolution. His Inauguration Day in 1841 was raw and cloudy, with a chill northeast wind blowing.

Ignoring the biting wind, the old soldier refused the offer of a closed carriage. Instead, without hat or overcoat, he rode "a mean-looking white horse" in the 2-hour procession from the White House to the Capitol, where his inaugural address took an additional 1 hour and 40 minutes. Later, he returned to the White House on horseback in another slow-moving parade. That night, after attending three inaugural balls, again lightly dressed, the hero of Tippecanoe returned exhausted to the Executive Mansion, where he suffered a "chill." The raw weather continued and

President Theodore Roosevelt and President-elect Taft drive to the Capitol through a howling storm in 1909 that dumped 10 inches of snow on Washington.

Harrison persisted in ignoring it, wearing neither hat nor coat, while the chill became a lingering cold. His cold deepened into pneumonia, and Harrison slipped into a coma. He died on April 4, 1841, a victim of his militant disdain for the elements.

In 1845, James Knox Polk took his oath of office in the pouring rain. A sea of umbrellas was all that could be seen from the temporary platform where the President-elect insisted on being sworn in. On the Mall below him, thousands of spectators stood ankle-deep in mud, and the rain drumming on their umbrellas drowned out Polk's inaugural address.

The parade back to the White House was a shambles. Floats had been reduced to soppy paper-and-cloth monstrosities, and as Polk's carriage moved up Pennsylvania Avenue in the downpour, the President saw mostly the backs of spectators splashing to shelter.

Franklin Pierce was inaugurated President of the United States on March 4, 1853; light snow fell most of the day. Snow greeted the President-elect when he awoke in the morning and continued until 11:30 a.m. President Pierce had just finished his oath of office and was beginning his inaugural speech when the snow began again. Cancelling plans for a parade back to the White House, Pierce dropped ex-President Millard Fillmore and his wife off at the Willard Hotel, then continued on to the Executive Mansion.

Abigail Fillmore, wife of the outgoing President, had caught a cold as she sat on the windy, exposed inaugural platform in near freezing temperatures, a cold that soon deepened into pneumonia. She died at the end of the month.

It rained hard early in the morning on Abraham Lincoln's second inauguration in 1865, and the Capital City was a sea of mud. According to the New York Herald, the streets were "flooded and afloat with a vile yellow fluid not thick enough to walk on nor thin enough to swim in."

Despite the mud and still-threatening weather, a good-sized crowd waited patiently in front of the Capitol and cheered when Lincoln came out. Dark clouds were scudding across the sky as Lincoln began his inaugural address, but soon sunlight broke through and lit the face of the Capitol behind him.

Ulysses S. Grant was the victim of a meteorological doubleheader. It rained on the morning of his first inauguration in 1869, and 4 years later, as we have seen, he was sworn in on by far the coldest Inauguration Day yet.

James Garfield's Inauguration Day took place on March 4, 1881. It snowed all the night before, and by midnight deep drifts were everywhere. The next morning, streets were impassable, except for Pennsylvania Avenue between the Capitol and White House, where workmen had spent the night shoveling the snow from the street onto the sidewalk as fast as it fell. The snow finally ended about mid-morning. Most of the decorations were ruined, and snow-covered bleacher seats originally priced

Herbert Hoover's inaugural parade splashes up rain-slick Pennsylvania Avenue on his March 1929 Inauguration Day.

at five dollars sold for fifty cents. There were few takers. As Garfield delivered his inaugural address a chill wind whistled through still-naked tree limbs, and the falling temperature hovered just one degree above freezing.

In 1889, despite his grandfather's fatal exposure 48 years earlier, Benjamin Harrison insisted on taking his oath of office and delivering his inaugural address in the pouring rain, then stood outside the rest of the day reviewing the parade. (The evening before Harrison had also taken his usual long daily walk in the rain.)

When the dripping Presidential procession arrived at the East Portico of the Capitol for the ceremonies, some 20,000 spectators stood waiting on the Capitol Plaza, their massed umbrellas buffeted by wind and rain.

Harrison took his oath of office under an umbrella, his words drowned out by the downpour. Despite his inaudibility, the President-elect delivered a very long, rambling inaugural address. When he finished, only a few thousand spectators remained; even his wife and daughter had gone indoors.

Still undaunted, Harrison went to the White House reviewing stand to watch the inaugural parade. By dark, the surrounding stands were deserted, except for a few solitary figures huddled under shiny black umbrellas. Harrison still stood there ignoring the pouring rain, as if settling a personal score with the elements.

Four years later, Grover Cleveland (who also preceded Harrison as President) started his second term in a snowstorm. Rain had been falling the previous evening, but by early morning had changed to snow. By mid-morning, when Cleveland left for the Capitol, the snow had tapered off, but a biting northwest wind was whistling through the city, and the temperature was in the 20's. Pennsylvania Avenue was almost deserted and Cleveland's mustache reportedly glistened with tiny icicles as the President-elect rode to the Capitol for the ceremonies.

Some 10,000 shivering people were huddled around the inaugural platform when the President-elect arrived; according to a contemporary account, many kept warm with "jokes and flasks." The snow stopped about one o'clock, but the wind whipped in icy blasts, cracking the robes of the Supreme Court justices like rifle reports. Cleveland clutched his high hat tightly in his left hand and began his inaugural address. The wind caught his words and carried them to the crowd. High winds continued throughout the day, and a fireworks display scheduled for the evening had to be cancelled.

Bad weather also cancelled the fireworks planned for William McKinley's second inauguration in 1901. Rain began during the swearing-in and continued through most of the afternoon. The crowd that witnessed the inaugural oath was described as the smallest in many years; only a handful of people sat scattered among the 7,000 seats facing the temporary platform erected on the East Portico of the Capitol.

In 1929, Herbert Hoover was sworn in, delivered his inaugural address, and then marched in rain that began just before he took his oath of office and continued throughout the day.

Just before the swearing-in, it began to rain very hard, but with an estimated

100,000 people thronging the Capitol grounds and nearby streets, Hoover went ahead with the outdoor ceremonies. The new President was drenched by the time he completed his inaugural address, his face beaded with water and his suit wringing wet. Nevertheless, he returned to the White House and, an hour or so later, was back outdoors reviewing the parade of 20,000 as it passed in the downpour.

The weather did little to dampen the spirits of the crowds which jammed Pennsylvania Avenue, making it impossible for anyone to run for cover during the downpours. Most of the spectators endured the drenching good-naturedly. Many, with water running down their faces and coat collars, laughed at the soaking, demonstrating considerable dexterity by clapping their hands and holding umbrellas over their heads at the same time.

Thirty two years later, the second worst snowstorm in the history of the event prevented Herbert Hoover's plane from landing in Washington, and he had to miss the inauguration of John F. Kennedy. The storm left nearly eight inches of snow and caused the most crippling traffic jam in the City's history.

Heavy snow began falling in the afternoon the day before, and by evening streets and roads were impassable. Thousands of motorists were stranded in the storm. Police switchboards were swamped with calls from people trying to find wives, husbands, and children who had not come home. Many of the missing were sitting in stalled cars trying to keep warm, where they would remain for hours before help reached them. Others simply abandoned their cars wherever they stalled, and set off on foot through the blinding storm.

The snow ended by sunrise, but it was bitterly cold, and strong, gusty winds were to blow all day. Snowplows and sanders had worked throughout the night, and the inaugural parade route was in reasonably good shape. By noon, when the ceremonies began, the temperature was a chill 22 degrees, and a biting 19 mile-per-hour northwest wind cut through the thickest clothing.

Some 20,000 shivering spectators sat huddled between snowbanks at the Capitol Plaza to witness the swearing-in. Later, despite the icy blasts, an estimated 1 million people watched the inaugural parade, which included 30,000 marchers, a PT boat, and the 8 surviving members of the crew Kennedy had commanded in World War II. As twilight came, the cold deepened and people began drifting away. By the time the last marcher had passed, the President, his brother Robert, and Robert's wife, Ethel, were almost alone on the reviewing stand.

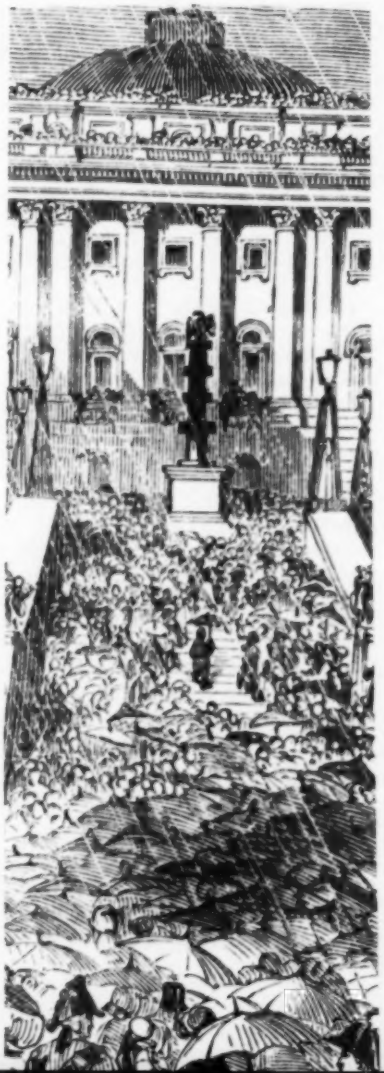
The experiences of Presidents Roosevelt and Kennedy show that you can lose even when the climatic odds are in your favor. FDR's saturated second inaugural ceremony was particularly ironic, since the 20th Amendment had just changed the date of Inauguration Day to January 20, and the new date supposedly favored drier weather.

Said harried Senator George William Norris of Nebraska, whose amendment changed the date: "They're trying to blame this on me.. You can't charge this up to me until after March 4, when you see what kind of day that is."

It was a beautiful day—sunny, with a high temperature of 67 degrees, unusually warm for that date.

And the weather on March 5, 1961 (March 4 fell on Sunday), the year of John F. Kennedy's January 20th snowstorm, was even warmer, with a high temperature of 80 degrees.

Indeed, since the change to January 20, the weather on the 12 old Inauguration Day dates (March 4 or 5) has been benign, as it was on the first seven inaugurations held indoors. In between there was rain, snow, or bitter cold on nearly half of the quadrennial Presidential Inauguration Days. ■



Inaugural spectators protect themselves the best they can during inaugural ceremonies for James K. Polk (1845) and Richard M. Nixon (1969). (Right-hand photo courtesy of John Atkins, Washington Star.)

America's Weather Birds ...Their Care and Feeding

Bud Littin

Since 1792 an American eagle—symbol of the determination and pioneering spirit of the American people—has been associated with most great undertakings of the United States, including Neil Armstrong's arrival on the moon in 1969, when he announced "the Eagle has landed."

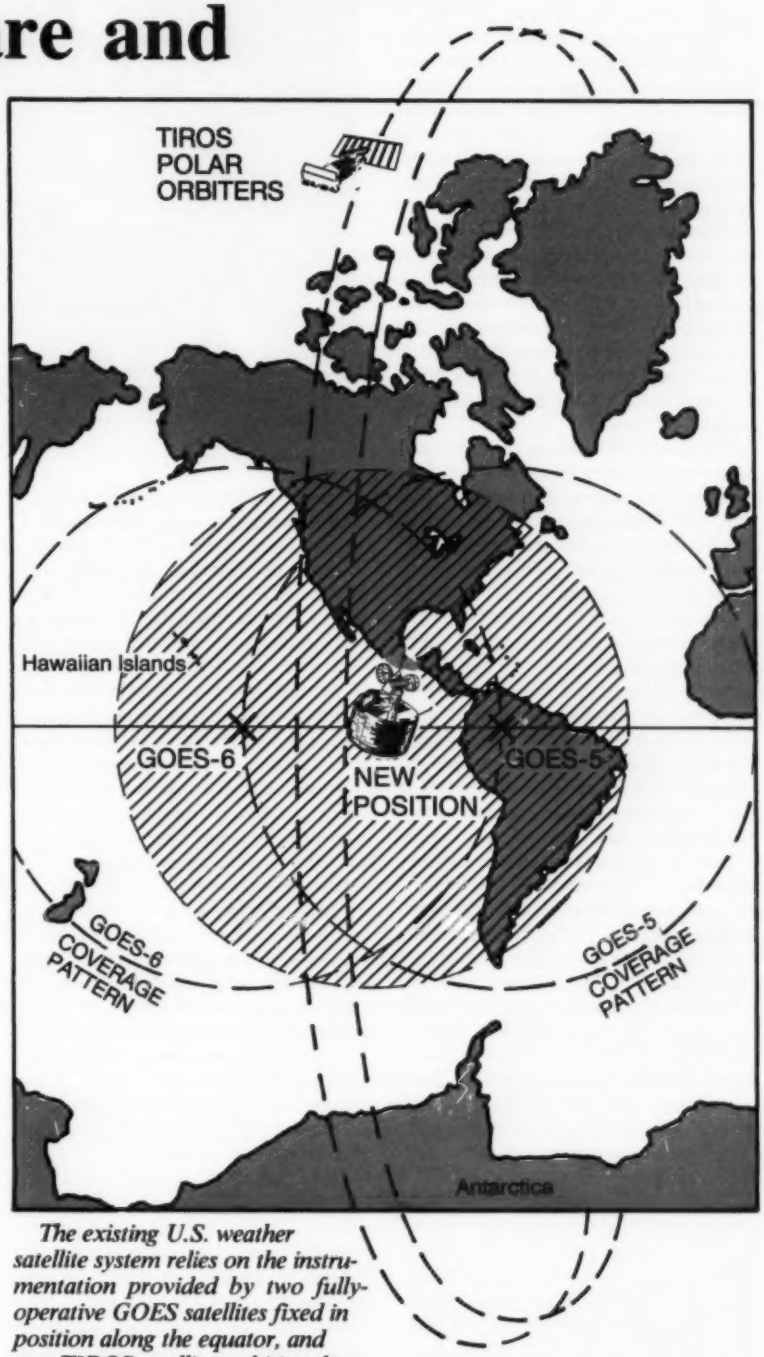
Today a special breed of national birds—NOAA's weather satellites—carry this symbolism as they circle the Earth gathering information vital to the everyday lives of people in the United States and more than 100 other countries.

These new American eagles in our lives are taken for granted, until one falters, as happened last summer. In July, home reception of TV weather pictures from space was interrupted for parts of the nation by a malfunction aboard GOES East, one of two primary NOAA geostationary satellites providing a veritable ocean of information daily on U.S. weather conditions.

Few people outside the space community have any idea how intimately these space birds affect our lives and fortunes. Fewer still can picture what goes on behind the scenes as satellite engineers, controllers, and computer experts constantly monitor their health, moving them about in space as the need arises, to keep essential information flowing.

NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) operates two types of weather satellites—polar orbiting (NOAA) and geostationary (GOES). It also operates earth resource-sensing satellites, known as Landsats.

Polar satellites circle over the poles 14 times every day at an altitude of 470 nautical miles. Their travel is synchronized with the sun. With each orbit, as the Earth rotates beneath them, they transmit data and pictures covering a swath nearly 1,700 miles wide, including Alaskan sea areas not covered by



The existing U.S. weather satellite system relies on the instrumentation provided by two fully-operative GOES satellites fixed in position along the equator, and two TIROS satellites orbiting the Earth over the Poles.

When the Imager on GOES—5 failed, GOES-6 was moved east to a new position over the equator, bolstering coverage in the hurricane-prone Atlantic.

GOES satellites. Being relatively close to Earth, they can produce readings in fine detail. In addition, polar satellites carry special instruments to locate and report downed planes and ships in trouble.

GOES (for Geostationary Operational Environmental Satellite) are in fixed positions along the equator more than 22,000 miles above the Earth, primarily assigned to watch U.S. weather developments. At their fixed positions they are able to cover a huge area—60 degrees in every direction every 30 minutes. In addition to picture taking, every 6 hours they collect and relay to ground stations readings from more than 10,000 data collection points on Earth.

Both polar and geostationary satellites gather visual images and basic weather data and monitor the space environment around the Earth.

Failure of GOES East last year focused public attention on the role of weather pictures from space but not on the unheralded achievements of the small band of cost-conscious men and women—fewer than 200—who keep these satellites operating.

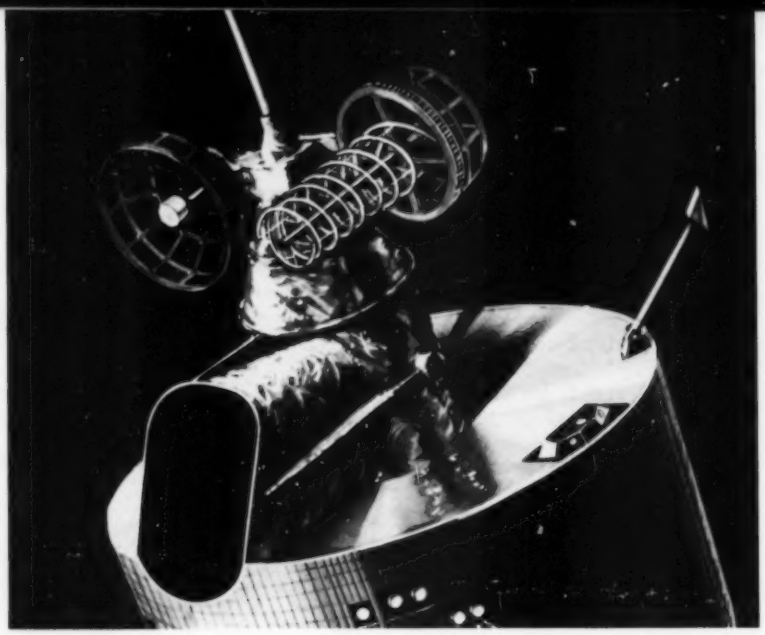
Day-to-day health, productivity, and improvement of our polar and GOES weather satellites is managed by a team from three specialized NESDIS units—the Office of Satellite Operations, the Office of Satellite Data Processing and Distribution, and the Office of Systems Planning and Development, located a few miles from Washington in surburban Suitland, Md.

Assisting this team over the years have been experts from NASA, the USAF, and private contractors, including the Hughes Aircraft Co., RCA Corp., Ford Aerospace Corp., and the Walter A. Bohan Co.

Gordon Vaeth directs the Office of Satellite Operations with Tom Karras overseeing NOAA's satellite control center. Russell Koffler directs the data processing and distribution. Larry Heacock, chief of systems planning and development, rides herd on improvements.

Karras, the day-to-day control center honcho, sees NOAA weather birds as individuals. To him their instruments are anatomical—ears that pick up information, eyes that pick up pictures, noses that sniff the surrounding environment, and mouths that feed the birds.

Meteorological spacecraft are loaded with sophisticated instruments, performing in a yet somewhat forbidding and mysterious environment.



How complex is this system? Consider that a home computer processes information in a range of 7,000 bits per second. (Generally speaking, a bit is a fraction of a word or number.) NOAA's global system feeds digital computers that can handle more than 1,000,000 bits per second, and the load is growing.

America's weather satellite system is built around the concept of four complete sets of satellite instruments, two polar orbiting and two geostationary, plus ground communications stations and the super-fast processing system.

In actual practice, because of the rigors of space plus the delicate nature of their innards, sometimes all four of these birds are not fully operational at once. In the past year, up to six GOES satellites in various stages of health have been marshalled to assure the output that two fully operational GOES spacecraft would produce. With the failure of the GOES East spacecraft, two birds are now paired up to do the job of one. That is, the eyes of one and the ears and mouth of another now are used to perform the job that normally one bird does.

Once each day, command signals are sent to each satellite, setting up a sequence of timed events. These are watched to spot anything that doesn't happen on time and as ordered. A controller always watches each of the four major satellites via computer signals, 7 days a week. Not surprisingly, some of the personnel are former FAA air traffic controllers.

Twice each year, when a satellite goes into eclipse, the operations staff does what Karras calls "a baby sitting job." Instruments are turned off for a thorough physical check-up, including battery cleaning by burning off corrosion.

A key design requirement for these satellites is redundancy—working elements installed in duplicate. If one fails, there is a backup. When an instrument shows signs of strain, it can be rested by switching it to standby. When GOES East quit sending pictures last year, however, both primary and backup TV light sources had failed within a matter of days.

Another feature of these birds is an array of small, rocket-like engines and 98 pounds of liquid propellant for after-launch maneuvers. These little rockets are used to correct attitude and to move the satellite to new locations.

Over the years, failures of instruments have been traced to such causes as gas leaks, oxidation, servo motor breakdown, bulb burnouts, sticking of moving parts, circuitry glitches, and premature aging of materials, among other things.

Satellites are subject to wide temperature changes as they travel under the sun or in Earth's shadow. Batteries power them through the shadow, solar panels under the sun's rays. They are subject to chills, even fevers, and NOAA's controllers know when to apply a "heating pad" or an "ice bag"—by commanding heat-release louvers to open or close. If a battery is showing strain or heat buildup, the controllers can manipulate the sequence of activities

GOES (left) and NOAA polar orbiters are the workhorses of the Nation's civil environmental satellite system.

to reduce it.

When a satellite develops too many ailments it is turned off and held in reserve, continuing to circle until its remaining capabilities are needed. When a polar bird becomes totally incapacitated, it is turned off. Incapacitated geostationary birds are kicked out of orbit into another higher altitude far off the main highway, where they will remain for hundreds of years before being consumed upon re-entering Earth's atmosphere.

Like a football team that fills gaps in its starting lineup from the reserve squad, when a malfunction occurs, the lineup of satellites in space is shuffled and reservists are activated.

When its imager failed last year, GOES East was stationed over the equator above South America, at 75 degrees west longitude. Its companion, GOES West, also was along the equator at 135 degrees west longitude, over the Pacific southeast of Hawaii. Together, they provided day and night coverage of the United States, the Caribbean, Central and South America and large portions of the Pacific beyond Hawaii and north to Alaska, and east almost to Africa.

With GOES East's failure, NOAA's controllers immediately activated a contingency plan that moved GOES West 37 degrees to the east (98 degrees west longitude), where it could cover the whole country, especially hurricane breeding grounds in the Caribbean and Gulf of Mexico. This maneuver took several weeks and, incidentally, consumed 4 pounds of fuel.

Last November, when the eastern hurricane season ended, GOES West was eased back to 108 degrees west longitude, where it continues to watch the continental United States, while also snooping for signs of winter storms forming in the Pacific. This spring it will again be shifted east to a position at 98 degrees west where it can watch summer storm formation, including tornadoes.

Satellites Serving the World Community

Information provided by NOAA's satellites directly affects countless daily economic decisions in many walks of life: wholesale and retail marketing, the construction industry, the insurance industry, planting and harvesting of crops, travel and shipping, air and ocean navigation.

Commercial TV broadcasters who feature daily weather programs are but a tiny fraction of the people whose lives—and livelihoods—benefit. Loss of life from hurricanes, tornadoes, and other severe storms has been sharply reduced by satellite early warning of their approach. When a full complement of these birds is aloft, no tropical storm in the world goes undetected.

Satellites help commercial fishermen by pin-pointing different temperature boundaries in ocean areas, providing vital clues to the whereabouts of saleable fish, including blue fin tuna, herring, swordfish.

Early warning of frost conditions can save citrus growers millions of dollars per day on cost of heating groves; indeed, a timely satellite warning can help salvage an entire crop. Likewise, satellite rain warnings are crucial to Hawaiian sugar cane harvesting. These satellites also can play a decisive role in forest management, including fire control.

NOAA's polar orbiting birds transmit snow and ice maps and melting advisories, enabling water supply managers to plan irrigation and flood control moves. This is especially important to our western states with their multi-billion dollar agri economies—where an estimated 70 percent of the water supply comes from mountain runoff. Thanks also to such ice monitoring, shipping on the Great Lakes now is extended into the winter months, generating millions of dollars of economic activity annually for Middle America, and neighboring Canadian provinces.

More than 100 nations are using our daily satellite transmissions, some of them also helping gather and process data with their own satellite operations and ground facilities. NOAA satellites offer a helping hand to developing nations in Asia and Africa, better equipping them to manage their food supplies by helping to forecast drought and rainy conditions.

Evidencing the global economic potential of America's polar satellites, last fall representatives of countries comprising the Annual Summit of Industrialized Nations met in Washington to form a new international organization pledged to advance the polar system. The group, International Polar Orbiting Meteorological Satellite Group, will meet again in Europe in 1986.

A polar orbiter link-up with Canada, France and the Soviet Union makes possible a cooperative search and rescue operation known as SARSAT. In a little over two years, instruments carried on U.S. and Soviet satellites have located and guided the rescue of nearly 350 people on land and sea, mostly in the United States and Canada. From a pure cost-benefit angle, by telescoping rescue time, this system is saving millions of dollars annually in aerial and sea searches by the Coast Guard, USAF, Canadian and other rescue services.

In December, 1984, the latest model polar orbiting satellite, known operationally as NOAA 9, was launched from Vandenberg Air Force Base in California. For 5 months before that, because of the sudden failure of NOAA 8—the lone U.S. SARSAT then in orbit—the Soviets carried on the rescue alerts.

Operational Satellites' 1985 Lineup

The "happy faces" diagram shows how five geostationary satellites will be configured along the equator for the coming year, beginning in February.

For the past 6 months GOES 4, which was launched in 1980, has been serving as a relay station at 135 degrees west longitude. Its health is precarious, however, and so it is being retired from active service in February, to be replaced by GOES 3.

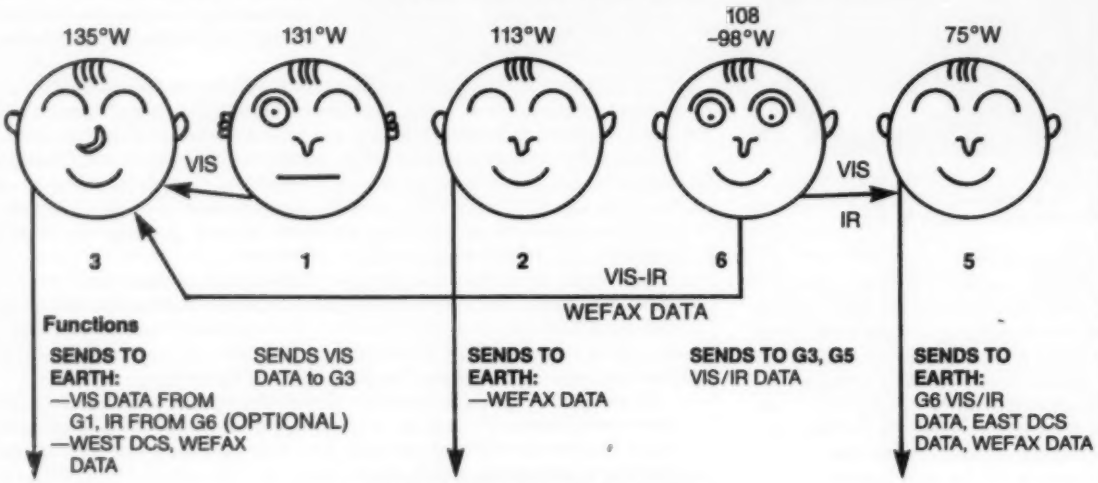
At 131 degrees west is GOES One, the 9-year-old satellite that NOAA's control center rocked back into partial operation last year.

At center position, 113 degrees west, is GOES Two, launched 7 years ago.

Alternating with the seasons at 108 degrees and 98 degrees west is GOES Six (aka GOES West), the only fully operational geostationary satellite.

At 75 degrees is the poor bird that lost its sight last July, GOES Five (aka GOES East) still functioning in every other respect.

GOES SATELLITE POSITIONS FEBRUARY, 1985-EARLY 1986



WHAT THE HAPPY FACES TELL US

GOES 6 above has eyes, ears, nose, and a happy mouth, while these features are missing or altered on the other faces. Here's what they represent:

EYES	visual and infrared imaging capability (VISSR)
EARS	ability to interrogate and report data collection platforms, a function which is degraded on GOES 1
NOSE	ability to monitor the environment around the spacecraft, a function shown to be degraded on GOES 3 below
MOUTH	smiling mouth indicates good power situation, degraded on GOES 1 above

Launch of a new GOES East spacecraft, it is hoped, can be expedited to take place in the winter of 1985, allowing GOES West to resume its original position over the Pacific.

If you think a 45 yard football field goal is artistic, consider the precision that goes into applying just the right amount of rocket push to move a satellite "between the uprights" thousands of miles away.

Last year, in an effort to boost reserve imaging capacity, a decision was made to burn fuel on a 9-year-old satellite, GOES One, to reactivate its image mirror, which had become stuck in place. "Much as you would rock your car to get it out of a snow rut, we used rocket motors to shake the satellite and jar loose its mirror, and it worked," explains Karras.

The NOAA team continues to discover new ways to succeed. What it learns is fed to NASA and to contractor companies. Today's satellites do a vastly bigger job than the early models. A constant process of improvement is taking place. Tomorrow's will be better yet.

This year marks the 25th anniversary of the first weather satellite, TIROS One, launched from Cape Canaveral April 1, 1960. There will be a reception at the Smithsonian's National Air and Space Museum in Washington honoring early bird scientists and others who made this breakthrough possible.

While these ceremonies are taking place, another team of pioneers will be on station in Suitland, Md., ready to play veterinarian to space-age American eagles 22,000 miles in space and hoping it won't be necessary. ■

DIVER BEWARE

Surviving Underwater Deathtraps

Jack Stringer

Dick Rutkowski walked to the front of the headshed, turned facing the group of ten divers and said, "A good dive is any dive when everyone comes back safe."

Then he paused, and casually looked around at the scattering of candy wrappers, paper cups, and soft drink cans and bottles on the floor and desks. "If you think I'm going to pick up your empty Pepsi bottles, you're 100 percent wrong!"

Rutkowski, who is the supervisor of NOAA's Miami Recompression Facility on Key Biscayne, Fla., waited patiently. It had been another 12-hour day, the third in a series of rigorous exercises to test equipment for the protection of divers operating in waters containing highly toxic substances. In spite of the tensions that, for the moment, had affected the group, the exercises would be the precursor of a highly successful demonstration in Seattle, Wash., within months.

In today's society, hazardous materials—from plastics to synthetic fabrics to pesticides—are a common and essential commodity of commerce. Many of these materials are transported by tanker, over road and rail and over water by barges and ships, and accidents are not infrequent as with all forms of transportation. In this case, however, an accident can have the compounding effect of endangering human health and the environment far removed from the scene as, for example, when a tractor-trailer wrecks and spills its cargo of highly toxic material into a river upstream of a township's drinking water reservoir.

In response to such possibilities, NOAA's Diving Office is developing standards to identify the special hazards which divers would be subjected to, and to determine what dress and equipment for both divers and surface support personnel should be used.

A diver is "decontaminated" at NOAA's Miami Recompression Facility.

Diver Cliff Newell shows the strain after completing heat stress tests.

Dr. Morgan Wells and Dr. Leonard Backman kept careful records during the tests.

In the mid–1970s, NOAA's Diving Office became concerned about the diving operations being conducted in the offshore sewage and chemical dumpsites in the New York Bight. The divers, who wore dry suits and free-flow helmets to prevent contamination, also were required to be immunized against the more commom disease-producing bacteria.

Four years ago NOAA joined forces with the Environmental Protection Agency and established an interagency agreement to identify the problems, locate commercial solutions and establish long- and short-term goals for equipment and procedures for those who must work in or near contaminated waters.

This concern for the health and safety of the diver resulted in the formation of a working group made up of people from EPA, U.S. Navy, U.S. Coast Guard, the Department of Energy, Undersea Medical Society, the University of Maryland, and NOAA—all of which obtained considerable advice from commercial diving companies.

During February last year, representatives from the working group met on Key Biscayne to conduct tests using modified commercial diving equipment and to develop safety and decontamination guidelines that would provide immediate protection of divers involved in a hazardous spill incident. Most of the work would be in, or in the shadow of, a 12–by–12 foot water-filled test tank at NOAA's experimental unit. NOAA divers Paul Pegnato, Steve Urick, Cliff Newell and Dr. J. Morgan Wells, Director of the NOAA Diving Office, would individually spend up to 30 minutes in the tank testing for suit leakage and diver heat stress. John Navaro, Art

Francis, and Bill Phoel were members of the surface support and decontamination teams. Personnel from Coast Guard and Navy observed the week-long tests.

The suit the diver wears should have strength, flexibility, thermal limits, cleanability, and, most important, chemical resistance. Damage to the material by a chemical agent may be as severe as complete deterioration of its protective qualities.

Richard P. Traver, of EPA's Hazardous Spills Staff, admits that a suit with the "finest design and manufacture may nevertheless be permeable and degradable while maintaining impenetrability."

Protective equipment for surface personnel should be selected on one of four levels chemical spill experts have established to determine personal safety. "Level A protection should be worn when the highest available level of both respiratory, skin, and eye contact protection is needed," Traver said.

"Level B, when the highest level of respiratory protection is needed, but cutaneous or percutaneous exposure to the small unprotected areas of the body such as the neck and back of head, is unlikely, or where chemical concentrations are known within acceptable exposure standards.

"Level C protection should be selected when the type and concentration of respirable material is known, or reasonably assumed to be not greater than the protection factors associated with air-purifying respirators, and exposure to the few unprotected areas of the body is unlikely to cause harm."

According to Traver, Level D is the basic work uniform, and should be worn for all site operations, and only be selected when sites are positively identified as having no toxic hazards.

When the Pepsi bottles had been removed and a general cleanup completed, Rutkowski managed to smile. "As we said before, Level B will probably never be used because you will probably never be in a hazardous area like that.

"The main difference between B and C is respiratory and whether the diver will bring enough stuff up with him to cause a hazard to the support team. We're pretty much looking at Level C, which means that maybe all the diver really needs is a good shower."

But it was there; the green, yellowish glow of the fluorescent dye around the nostrils and ears of Cliff Newell who,

At left, tenders assist a diver about to go into a testing tank. Above, NOAA divers Paul Pegnato and Dick Rutkowski share a joke during a hazardous substance diving demonstration in Seattle, Wash.

after spending about 20 minutes in the tank wearing a Viking Mark 12 suit and a U.S. Navy Mark 12 helmet, had been scrubbed, stripped and thoroughly exposed to a black light that would indicate possible body contamination. Later, it was determined that the tiny particles of fluorescence had originated from Newell's shampoo and were of a slightly different color than the tracer.

"Our main concerns," said Dr. Leonard Bachman, NOAA's Fleet Medical director, "are to prevent ear and skin infections, prevent aspirating polluted water through the air regulator, and making sure the diver is properly cleaned off when he comes out of the water."

Bachman and Wells, seated next to an ECG machine and another device that measured body and helmet temperature, carefully monitored the paper strip and an oscilloscope screen as Newell, in the tank, performed a series of physical exercises to induce diver heat stress. Because Newell's body, fully encapsulated in clothing, was shielded from normal circulation of air, his perspiration would not evaporate, eliminating his body's main mechanism of cooling.

"With that gone the body is prone to heat stress which can be exhibited as heat stroke or heat exhaustion," said Bachman. "This is very common as the ambient temperature rises."

"Wrist rotate, 20," said Wells who asked Newell to perform a specific number of exercises through the communication box connected by cable to his helmet. "Wrist flex, 20. Invert. Stand quiet. Three minute rest." With the water temperature heated to 107°F, Newell's core temperature increased to 38°F.

"He's going up 1/10° a minute," said Bachman.

"Bring him up," Wells said. Newell came out of the tank at 38.5°.

The decontamination team assisted Newell to a roped-off area called the Hot Zone where the spray down began. With his outer garment off, his skin temperature began to cool. "You notice that difference," he said.

Although Newell felt he was improving, the monitor contradicted his assessment. His core temperature was still going up.

"Hyperthermia is that kind of a problem," Newell said. "You don't know you're getting it until you get it. And then you don't know it anyway."

Wells and Bachman advise divers to wear long underwear under their outer suits to absorb perspiration allowing the greatest amount of cooling by evaporation. "This will also protect the body from burns from the suit itself," said Wells. "But the best way to prevent heat illness is to limit the amount of work in the suits."

In the briefing room, Rutkowski had called on Paul Pegnato, senior staff assistant, to explain the new concept in div-

During a simulated emergency, the support team aboard a tug stands by while divers search for "contaminated" material underwater. At right, Marc Kaiser (left) and Dr. Morgan Wells tend diver Clifford Newell during tests.

ing systems involving the suit developed by Wells and Steve Urick. Described as a suit under a suit, Pegnato said it consists of a tight fitting, black neoprene drysuit under a modified Viking suit with an extra neck yoke inside the suit to create a seal between the two suits. The seal is created by a neck ring and clamp.

"Over the Viking suit there is a restraining garment which offers protection from abrasions and punctures, and restricts the suit from blow-up," he said.

"Hot or cold water is pumped in between the Viking and the undersuit for temperature control. This forces the air out, filling the area with water. The undersuit keeps the diver dry.

"Two exhaust valves are located on the ankles on the Viking suit where the water vents out. The diver can adjust the water pressure inside the suit by an exhaust valve on the upper left arm. Once the suit empties air and fills with water, the water continues to flow out of the two exhaust valves located on the ankles." The diver is now not only getting thermal protection but the positive pressure will keep the contaminant from entering the suit even if the suit is punctured.

The proof of the effectiveness of this system was obtained during the final two tests in the water tank. Wells, wearing an air filled protective suit, experienced significant heat stress while undergoing a 20-minute exercise period in 107° water. The following day he performed three successive 20-minute exercise periods in 112° water with no heat stress using the positive pressure, cool water suit called the SUS for Suit Under Suit.

"We have the hazard protection and the ability to warm or cool the diver depending on the environment," Pegnato said, citing that the unique aspect of the system is that a diver's buoyancy is much closer to neutral than many of the existing systems because less weight is needed on the diver. A drawback to the system, however, is that you need a clean water supply and you have to control the water temperature.

Pegnato turned the briefing over to Rutkowski who had several critical comments about the decontamination team and tenders. "There was a weakness in the beginning," he said. "I had to go around and tell a few people to do some things that they should have done, such as checking the sprayer out." His other observations concerned the possibility that the sprayers would blow contamination through the seams and even in the cuffs of the suits, more care should be exercised when removing the helmet, and additional time is necessary to clean off the tenders themselves.

It was agreed that two supervisors are necessary; one for the divers and one for the ground and support teams.

Six months later, many of the participants of the Key Biscayne exercise gathered in Seattle, Wash., for a field evaluation and demonstration of diving equipment and procedures developed for a hazardous substance diving operation.

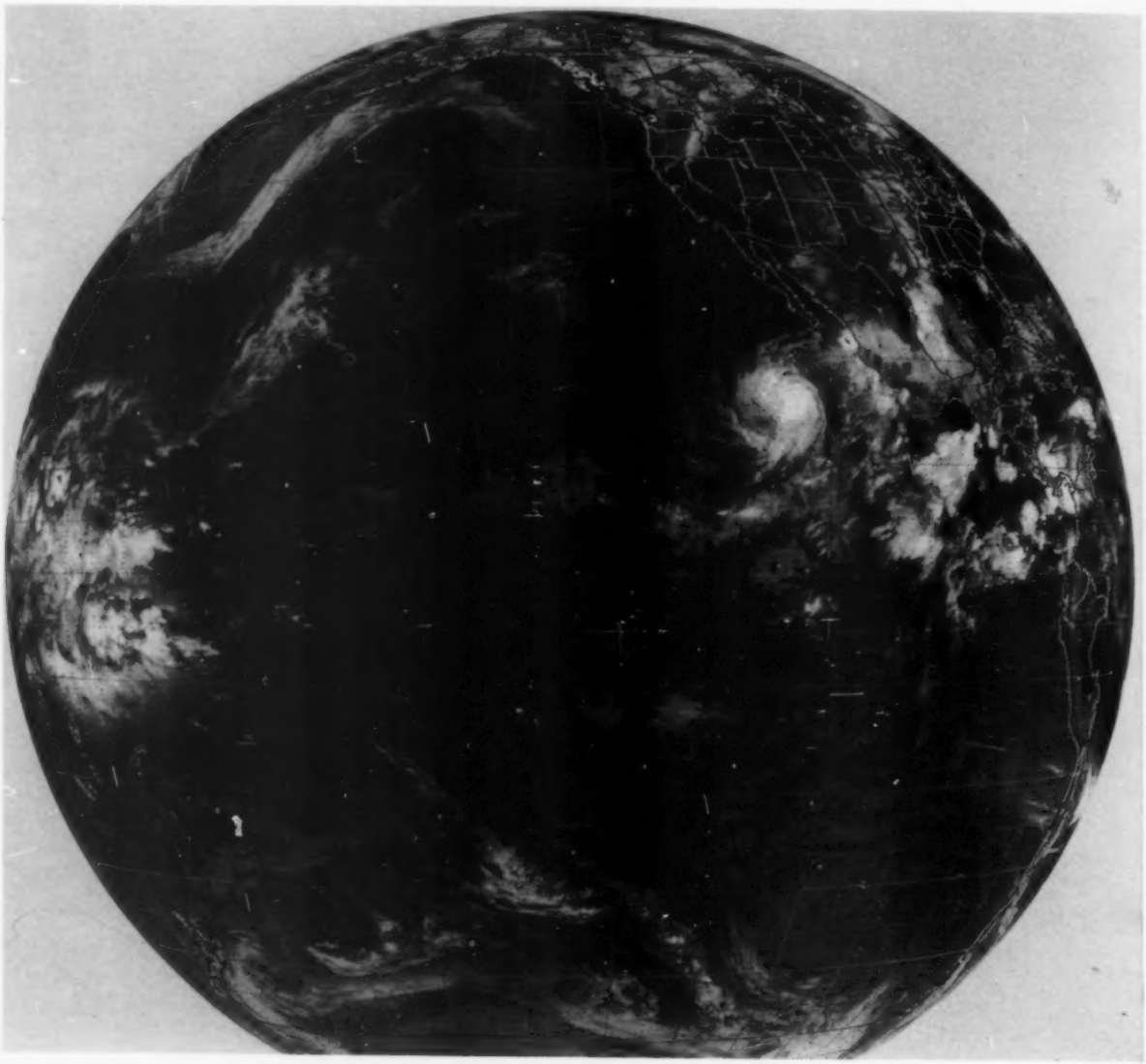
For the first time, 15 Coast Guard National Strike Force dive team members had the opportunity to use the equipment in what Wells called "a real-world situation." The divers, who wore maximum protection diving equipment, had to locate and remove drums containing "hazardous substances" from the lake bottom, often utilizing vacuum cleaners and underwater jets to uncover the buried drums. NOAA also demonstrated equipment used for underwater cutting, tide gauge installation, current meter maintenance—all tasks commonly performed by NOAA divers.

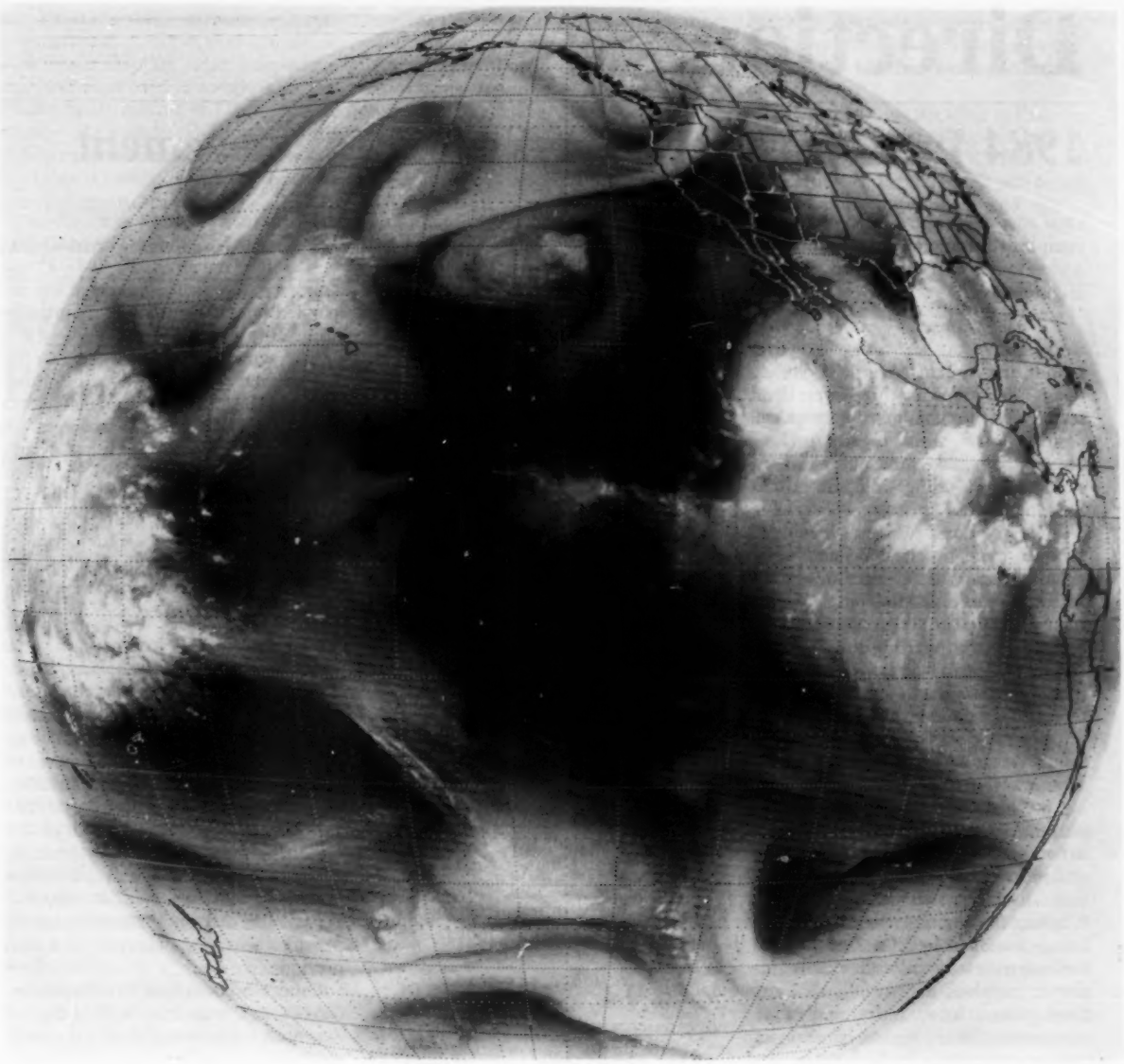
The divers and support teams worked with a cohesion that exemplified not only a thorough knowledge but a willingness to share this knowledge with representatives from state and federal agencies, the private sector, and even students from a nearby dive school. A manual will be published early this year that will detail how to use the new equipment.

In the meantime, across the country, there are nearly 15,000 chemical spills in waterways each year. Between 1977 and 1981, those spills included 76 million gallons of toxic chemicals in liquid form and 21 million pounds of dry chemicals. These are potential underwater deathtraps that only the most thoroughly trained and equipped diver should attempt to enter. ■

VIEW FROM SPACE

Now you see it,
Now you don't.





Space platforms such as NOAA's Geostationary Operational Environmental Satellites are able to give weather scientists more than just a human's–eye view of the Earth below. These GOES images demonstrate the satellites' ability to pick out distinct data—in this case water vapor—for study.

Both of these photographs of the eastern Pacific were made with infrared instruments at nearly the same time.

In one, the vague scattering of clouds to the northeast of Hawaii between the islands and the mainland are the only indication of upper level activity. Careful study would be required to notice and analyse the existence and extent of the vague gray swirls indicating upper air activity.

A glance at the second photo, however, which was made using another IR channel, clearly shows two separate systems with well-defined boundaries. The grey tones represent the net temperature of water vapor through a layer of the atmosphere in addition to cloud top temperatures.

Such images are invaluable to meteorologists seeking synoptic scale information in regions of sparse data. ■

Directions

1984 In Retrospect — A Year of Achievement

Over the past year, NOAA has accomplished numerous achievements in a wide variety of services and disciplines. Highlights follow:

At the *National Weather Service*, work began on an automated river monitoring system for the Colorado River Basin, following three severe flood seasons. The satellite-linked network will continuously monitor streamflow, precipitation, and temperature in a four-state area, including Colorado, Utah, Arizona, and California, allowing NOAA's National Weather Service to produce more timely flood and water supply forecasts. The initial 82-station network is scheduled for completion by the fall of 1985.

A heat index, alerting local officials and the public to health hazards during heat waves, was initiated by local National Weather Service forecast offices. The new index is a measure of the contribution that high humidity makes with abnormally high temperatures in reducing the body's ability to cool itself. It provides assistance to local governments in coping with the needs of the elderly and infirm.

A display system called Satellite Weather Information System (SWIS), being developed by NOAA, will allow forecasters to see motion in clouds and give an improved analysis of local storm development, rate, and direction of movement. SWIS, for the first time, presents satellite information to forecasters in an animated format.

At the *National Ocean Service*, a second Ocean Service Center was opened in Anchorage, Alaska (the first opened last year at Seattle, Wash.) to provide a "one-stop" location for delivery of all NOAA marine products and services to the regional user community.

Technical support was provided the Coast Guard on 107 oil and toxic chemical spills in estuarine and ocean waters. Services include trajectory modeling, toxicological and safety information, coordination of on-site activities, and risk identification.

In support of economic development and management of the 200-mile Exclusive Economic Zone proclaimed by the President, NOAA took a lead role in a multi-year program of bathymetric and geophysical surveys. NOAA ships began collecting a variety of data including bathymetric, magnetic, gravity, and seismic reflection profiles.

Licenses were issued to three multinational U.S.-based mining consortia to carry out exploratory mining for manganese nodules in the Pacific Ocean south of Hawaii. Also, the United States and seven other nations signed an international agreement which protects rights of mining consortia and avoids conflicts over use of seabed mining sites.

The Delaware River and Bay were the subject of a demonstration of a new approach to the provision of predictive circulation data based on models and real-time data acquisition. The approach enables NOAA to predict tide and tidal currents based on meteorological effects as well as astronomic forces.

The National Ocean Service issued 2.65 million copies of 1,482 different nautical charts, daily tide predictions for 6,200 ports and harbors in U.S. and foreign countries, and 9.29 million copies of 5,270 different aeronautical charts and related publications.

The *National Environmental, Satellite, Data, and Information Service* began negotiating with Earth Observation Satellite Company of Arlington, Va. for the commercialization of the civil land remote sensing satellite.

Landsat 5 was launched March 1, 1984, after Landsat 4 developed a series of technical problems that severely curtailed its capabilities.

In July, one of NOAA's Geostationary Operational Environmental Satellites failed. Another satellite was promptly moved to a new position, enabling uninterrupted coverage of the continental United States. Later, a third satellite was reactivated to provide additional coverage.

NOAA moved to upgrade the timeliness and reliability of its Assessment and Information Services Center drought/food shortage alert cables to U.S. Missions, as the NOAA/AID Early Warning Program for FY 1984/85 was approved. Assessment coverage was expanded from the current 72 countries to 100 countries.

The agency expanded its role in the U.S. Search and Rescue Satellite Aided Tracking (SARSAT) program that locates downed aircraft and ships in distress. A program office was established which will assume control of the project from NASA early in 1985. A key activity will be to work toward international recognition and use of the new system which, as of mid-September 1984, had played a part in saving 260 lives by identifying and locating ships and planes in need of rescue.

The *National Marine Fisheries Service* notes that the continuing success of the 200-mile U.S. fishery conservation zone was demonstrated in 1983 as American fishermen landed 6.4 billion pounds of edible and industrial fish and shellfish, up about 71 million pounds from 1982 and just shy of the 1980 record of 6.5 billion pounds. Other nations, fishing in the U.S. zone, took only 2.9 billion pounds of fish and shellfish, about 7 percent less than in 1982 and some 19 percent below the average for the previous five years.

Other NMFS–supported efforts to increase the economic well-being of American fishermen, included stepped-up joint venture operations, through which U.S. fishermen sell their catches at sea to foreign contractors. NOAA also pushed aggressively to further reduce fisheries trade barriers in nations that fish U.S. waters, with the ultimate aim of increasing the nation's fish exports and bringing about a more favorable balance of trade.

Fisheries enforcement agents, with placement of U.S. observers on almost all foreign fishing vessels, continued to guard against violation of federal laws and to help gather much-needed data on fish stocks and foreign fishing efforts.

The *Office of Oceanic and Atmospheric Research* has prepared maps

of winds, waves, turbulance, and thunderstorm outflows through use of an airborne Doppler radar. Researchers also have succeeded in compressing the extraordinary volume of Doppler radar weather data and combining it with lightning strike data for transmission to National Weather Service Forecast Offices for operational use.

Two cruises by NOAA research ships investigated hydrothermal venting on the sea floor, one in the eastern Pacific and the other along the mid-Atlantic Ridge. In the latter, three new venting sites were identified as slow-spreading undersea ridges, suggesting such locales could be having a definite impact upon ocean chemistry.

Computer models supporting NOAA's work in air quality and climate were developed. One model is able to simulate the atmospheric El Nino-Southern Oscillation phenomenon, a capability which may lead to improved predictions of this weather-effecting occurrence.

The OAR is investigating radiatively important trace atmospheric constituants which may contribute to a warming of the earth's climate. Models are being used to study tropospheric and stratospheric ozone concentrations with promising results.

NOAA Awards, Commerce Medals Honor Employees

NOAA Awards

On October 4, NOAA Administrator John V. Byrne presented NOAA Awards to nine employees for their outstanding service.

The winners were:

Edward H. Young, Jr.; Southern Region, National Weather Service; the Equal Employment Opportunity Award for progressive and energetic leadership toward the involvement of minorities in NOAA's disaster preparedness efforts.

John G. Boreman, Jr.; Environmental Research Laboratories; a NOAA Award for scientific studies advancing understanding of low-level wind shear and for continuing dedication to the improvement of aviation safety.

Frank I. Gonzalez; Pacific Marine Environmental Laboratory, National Marine Fisheries Service; a NOAA Award for outstanding research in coastal wave forecasting.

Richard C. Pryzwarty; Alaska Region, National Weather Service; a NOAA Award for significantly improving services in the Marine Weather Program.

Diana F. Lewis; Office of Marine Operations, National Ocean Service; a NOAA Award for exceptional contributions to administrative support of the NOAA fleet.

Dennis K. Clark; Office of Research and Applications, Climate and Earth Science Laboratory, National Environmental Satellite, Data, and Information Service; a NOAA Award for optical and electronic engineering creativity demonstrating the utility of ocean data from NOAA satellites.

William E. Carter; Advanced Technology Section, Geodetic Research and Development Laboratory, National Ocean Service; a NOAA Award for creative and dynamic leadership in initiating and making operational the POLARIS polar motion monitoring network.

F. Lorraine Bodi; Northwest Region, Office of the General Counsel; a NOAA Award for legal accomplishments in the area of fishery conservation and improvement.

Commerce Awards

Department of Commerce Gold and Silver Medals were awarded by Secretary Malcolm Baldrige in ceremonies November 13.

NOAA employees winning Gold Medal Awards were:

Dr. Ray E. Jensen, National Weather Service, Fort Worth, Tex., for highly effective management of regional warning and preparedness activities and outstanding leadership as an innovative manager.

Richard A. Severtson, National Marine Fisheries Service, Seattle, Wash., for significant contributions to the protection of the United States' fishery resources.

Steven W. Clark and James R. Smith, National Weather Service, Jackson, Ky., for spontaneous, extraordinary life-risking actions taken to rescue a badly injured and helpless pilot from a downed helicopter on June 8, 1983.

Dr. Melvin W. Eklund, National Marine Fisheries Service, Seattle, Wash., for outstanding research accomplishments in botulism with significant contribution to public health safety and identification, control and prevention of a major fish disease.

Rear Admiral Charles K. Townsend, National Ocean Service, Seattle, Wash., for outstanding leadership, energy, and ability in managing the Pacific Marine Center, 1980-1984.

NOAA winners of Commerce Silver Medal Awards were:

Wilber R. Seidel and John W. Watson, Jr., National Marine Fisheries Service, Pascagoula, Miss., for significant contributions to the management and conservation of endangered and threatened sea turtles.

Richard A. Snay, Michael W. Cline, and Edward L. Timmerman, National Ocean Service, Rockville, Md., for innovative modeling of California's crustal motion necessary for the readjustment of the North American Datum.

Stanley A. Spivey, National Weather Service, Fort Worth, Tex., for achievements in the field of office automation that have advanced major National Weather Service programs.

Malcolm Reid, National Environmental Satellite, Data, and Information Service, Washington, D.C., for excellence in developing operational climate impact assessments and inspiring others working in the field of climatology.

John J. Carey, Office of Budget and Finance, Washington, D.C., for outstanding contributions to NOAA and DOC by improving the Agency's budget and financial management systems.

Dr. Vaughn C. Anthony, National Marine Fisheries Service, Woods Hole, Mass., for improving assessment of North Atlantic fish stocks, aiding their conservation, and benefitting American fishermen.

William J. Alder, National Weather Service, Salt Lake City, Utah, for his acts in protecting the lives and property of the people of Utah, before and during the disastrous spring floods of 1983 and 1984. ■

SLEEPING GIANT

Mt. St. Helens: Delayed Action Danger

The debris-clogged North Fork of the Toutle River with Mt. St. Helens in the background.

Don Witten

This winter, National Weather Service forecasters in the Pacific Northwest will look west to the Pacific Ocean as they always do, watching for what the season will bring in the way of possible storms and floods.

But their surveillance this year is with special concern, as it has been every winter since Mt. St. Helens erupted on May 18 and 19, 1980. Debris deposited in the valleys below has reduced their waterways' carrying capacity and dammed lakes to the extent that 40,000 people downstream live in danger of severe flooding and mud inundation.

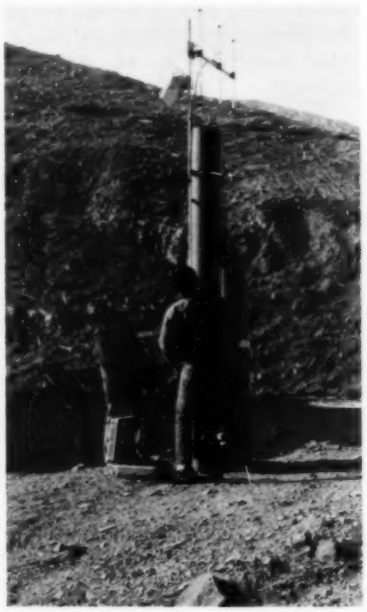
In relieving its pent-up stress, the volcano dumped about 4 billion cubic yards of ash, rock, dirt and vegetation into the North Fork of the Toutle River. This debris, enough to fill two million Olympic swimming pools, reduced the river's capacity by 75 percent.

And then there is that unstable dam of debris blocking Spirit Lake at the northeast foot of Mt. St. Helens. It holds back millions of gallons of water from the North Fork of the Toutle River, which flows into the Cowlitz and Columbia Rivers to the west.

Within 2 weeks after the eruption, the U.S. Congress acted. A special appropriation of $500,000 was made available to the National Oceanic and Atmospheric Administration to develop an automated flood monitoring and reporting system for Mt. St. Helens. Completed in time for the 1980 winter flood season, this network was developed under the management of the National Weather Service's Office of Hydrology and the NWS Western Regional headquarters in Salt Lake City, Utah.

"It is the most unique and largest flood monitoring network ever developed utilizing all of the available technology for data collection and communications," said Dr. Robert Clark, Director of Hydrology at NWS Headquarters.

The new system provides the Weather Service Forecast Office in Seattle, Washington and the NWS Northwest River Forecast Center (NWRFC) in Portland, Oregon with nearly instant rainfall and river-level reports of the drainages and waterways in the Mt. St. Helens area. The Seattle Forecast Office, under the direction of Washington State Area Manager, Richard Hutcheon, is responsible for providing weather and flood warnings for the State of Washington. The NWRFC issues flood guidance and water stage data for streams and rivers in Washington, Oregon and Idaho. This Center is headed by Dr. Vernon C. Bissell.



National Weather Service electronics technicians examine a lake level gage near the volcano.

In developing the flood monitoring system, NWS installed 32 automated rain and river level gages in a 200 square mile area covering the waterways north and west of Mt. St. Helens. Rainfall of four one-hundredths of an inch and river and stream level stage changes of a tenth of an inch are reported as they occur to the Seattle and Portland offices.

This system is augmented with data from a number of river and lake level gages installed in the area by the U.S. Geological Survey (USGS). During critical weather situations, information from these gages is relayed by the NOAA Geostationary Operational Environmental Satellites (GOES) directly to the Seattle Forecast Office by way of a special satellite ground station operated by the USGS at Tacoma, Wash. The GOES satellite also relays all USGS-provided information to the National Meteorological Center in Camp Springs, Md. for further relay to NWS offices.

NWS also erected a special NOAA Weather Radio transmitter atop Mt. Boistfort Peak to relay flood warnings directly to residents in the valleys and riverside settlements threatened by floods.

"So far, nature has been kind and we haven't had to put the flood monitoring network to test under severe weather conditions. But this could be the year," said Hutcheon.

When Mt. St. Helens erupted on May 18, 1980, it was with an unholy roar

This is the area in southwest Washington where thousands live in danger of flooding and mud inundation.

heard for hundreds of miles. Within hours, a landscape of picture postcard perfection was transformed into an unforgettable vision of hellish fury. The eruption occurred with such force that it devastated a 156 square mile area, claiming at least 50 lives, and producing incalculable damage to the area's agriculture, forests, waterways and wildlife.

The eruption blew off the top 1,300 feet of the volcano. Hurricane force winds generated by the blast uprooted enough trees to build 150,000 homes. In addition to filling rivers and other water bodies to the north of the mighty mountain, this debris dammed the outlet for Spirit Lake. No sooner had it formed, than this mile-wide dam began eroding.

"It was like watching ants at work. Every time we observed the dam it had changed," said Mark Fair, NWS Western Region Warning Preparedness Meteorologist at Salt Lake City.

By the summer of 1982, it was evident that the unstable lake would fill to dangerous levels within the year. Upon request of Washington State's Governor John Spellman in September, the President issued a Declaration of Emergency for the hazard created by the Spirit Lake debris dam.

The U.S. Army Corps of Engineers immediately swung into action to lower the water level of Spirit Lake with a pumping operation, which has stabilized the lake temporarily. The Engineers Corps is now drilling a tunnel to provide for permanent drainage of the lake at 20 feet below its current level. This operation is expected to be completed by next summer.

As the Corps of Engineers began lowering the swollen Spirit Lake, special

Mt. St. Helens spews smoke and tons of ash into the air during its 1980 eruption. The effects still plague the area.

Above, State of Washington Area Manager Dick Hutcheon inspects log-strewn Spirit Lake. At left, Thomas Swift, Deputy Meteorologist in Charge at Seattle's Weather Service Forecast Office (standing), and hydrologist Lee Krogh analyze data from the automated flood monitoring and reporting system for Mt. St. Helens.

monitoring gages were installed to warn of a collapse of the lake's debris dam. This complicated system, funded by the Federal Emergency Management Agency, provides data to the forecasters at Seattle by three independent communications links. Computers are used to sample the data and sound the alarm if critical changes are observed.

Washington state agencies are overseeing the efforts to mitigate the flood hazards created by Mt. St. Helens. Cowlitz County departments also are involved in the development of warning systems, including the installation of sirens and the conduct of public preparedness campaigns.

A report issued by the USGS in January 1983 indicated that, in the worst case, a breach of the Spirit Lake debris dam would result in a peak discharge of clear water at the rate of 530,000 cubic feet per second. When combined with the sediment in the North Fork of the Toutle River, this would generate a mud flow at the rate of over 2.5 million cubic feet per second.

When the engineers translated these figures to practical terms, it meant that the cities of Castle Rock and Lexington would go under as much as 60 feet of mud. Toutle, Toutle Lake, Kelso, and Longview also would be covered by as much as 30 to 40 feet of mud while other communities downstream would be inundated by as much as 20 feet of mud.

"Forecasting floods in the Pacific Northwest is difficult enough under normal winter conditions," said Richard Hutcheon. "But the eruption of Mt. St. Helens has complicated the problem significantly."

During the winter months, he explained, Pacific storms deposit snow on the western slopes of the Cascade Mountains. Often, these storms are followed by warm air systems which can produce heavy rains.

"With the rivers filled and Spirit Lake dammed by volcanic debris, we are concerned that unusually heavy rains will result in severe floods," Hutcheon added.

He also noted that there is always the threat of a new eruption by Mt. St. Helens, which would be critical during the winter. Melted snow mixed with dirt, ash and rock would create new mud flows and cause flash flooding on the Toutle River as has occurred several times since the initial eruption.

What are the chances of another major eruption of Mt. St. Helens? A look at the volcano's history might provide a clue.

As volcanoes go, Mt. St. Helens is a youngster; its visible cone probably dates back to no more than 1,000 years. It is the mountain's frequent activity during the past several thousand years that had geologists convinced it would put on a pyrotechnic display before the century was out. During this time, it has been more active than any other volcano in the contiguous United States. Alaska and Hawaii both have several active volcanoes.

Geologists note that Mt. St. Helens has probably had catastrophic eruptions like that of Mt. Vesuvius which buried Pompeii in 79 A.D. As evidence, they point to traces of ashfall from previous Mt. St. Helens' eruptions found in geological testing in eastern Montana and southern Alberta, Canada.

The mountain's first well-documented eruption occurred in 1842. The fireworks continued for 15 years then quieted down for about 3 years with the last report of activity in 1857. After that, the mountain slipped into geological slumber, from which it would not awaken for 123 years.

In the more than 4 years since Mt. St. Helens erupted in mid-1980, it has smouldered and threatened with several minor eruptions. Only time will tell if the volcano is now building to another major eruption.

While the NWS forecasters in Seattle and Portland will keep a constant vigil on the Pacific for flood-producing storms this winter, they also will cast a frequent eye towards Mt. St. Helens. ■

Fish Flourish In New Neighborhoods

Brian Gorman

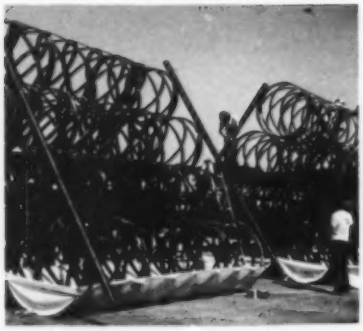
"Fish gotta swim, birds gotta fly," says the song. True enough, but fish and birds—in fact, all animals—also need something scientists call habitat, places where they can breed, find protection from their enemies and sources for their food. Many fish find their habitat near the shore, in bays and inlets, estuaries and marshes. As you get farther from the shore, fish populations generally diminish. In fact, much of the open ocean is a vast fish wasteland, unable to provide those basic elements that define habitats.

This information comes as no surprise to fishermen. Sport fishermen especially have known for centuries that the best places to fish were areas with irregular bottoms: old shipwrecks, rocks, submerged tree stumps, reefs. Shoreline habitat is not static, however. Natural and man-made changes can eliminate once productive habitats. As far back as the early 1800s, for example, South Carolina fishermen realized that their sheepshead catches were falling as forests on the barrier islands were cut down and the land cleared to grow sea-island cotton. In a review of the history of artificial reefs, Richard Stone, of NOAA's National Marine Fisheries Service, reports that sheepshead had been caught in large numbers around trees that had fallen into the waters along the eroding banks of the barrier islands.

"The trees became covered with barnacles and other marine growth and provided food and shelter for the sheepshead," he explains. "As the trees disappeared, so did the sheepshead."

While the fishermen in South Carolina may not have been the first to notice that the most productive fishing spots were near these irregular bottoms, they were among the first to try to do something about correcting the situation when catches declined, according to Stone.

A string of tires provides a durable and inexpensive habitat for fish. Such artificial reefs furnish a home for barnacles and other marine life which attract hungry fish to the area.



Almost anything that will sink could make a successful artificial reef. The ultimate test: better fishing. (Top photo ©1981, Aquabio, Inc.)

"They built wooden structures that looked like huts without roofs and floated them to the areas where they had previously found sheepshead," he says. Once these "huts" were sunk by filling them with stones or live oak, providing a setting place for barnacles and other marine growth, the sheepshead returned and catches once again increased. Thus began what were probably the first "artificial reefs" in the United States.

Artificial reefs, which can be either natural or man-made materials, are objects that are intentionally placed in selected marine areas to create or improve the bottom habitat. Almost anything that will sink, from old Liberty ships to discarded toilet bowls, has been used as artificial reef material, but some are far more effective than others. Old cars and other vehicles can be useful for a few years, but are usually reduced to debris by corrosion and wave action fairly quickly. Wooden structures, like those used by the South Carolina sheepshead fishermen, are destroyed even more rapidly by wave action and marine borers. Material like old tires, rock, or concrete rubble have proven effective, because they are both cheap and durable, if properly prepared.

There is no longer any serious debate about the intrinsic usefulness of artificial reefs. While they unquestionably attract fish, they just as frequently can create whole new populations that would otherwise never have existed. And since the site of an artificial reef can be selected ahead of time, the structures can serve as a more convenient location for fishermen, allowing them to get to productive fishing grounds more quickly and easily. But, as Stone explains, there is more to building an artificial reef than selecting some cheap, durable material and dumping it into the water.

"Installing artificial reefs without any thought about location of material can be a waste of time and money," he claims. In addition, he adds, reefs can't be located so that they will be a hazard to navigation, which means both the U.S. Coast Guard and the Corps of Engineers must be consulted. Finally, in most cases, they need to be clearly and permanently marked so they can be found.

All this means that the design, construction, installation and maintenance of artificial reefs is a job that involves a lot of people. Most of the successful reefs built in the United States have been cooperative efforts, involving federal and state agencies, industry groups and fishermen.

Recent passage of the National Artificial Reef legislation insures that federal agencies will work with one another and with the states, universities, and the private sector on planning for orderly, effective artificial reef development.

Although the primary use for artificial reefs in this country has been to enhance recreational fisheries, the Japanese, who eat more fish per capita than any other people, have used them mostly for commercial fisheries, beginning as long ago as the late eighteenth century. In fact the Japanese government has budgeted millions of dollars for artificial reef design and construction in recent years, and the fishing industry in cooperation with the government has spent several billion dollars over the past decade on artificial reefs.

Not surprisingly, Japanese reefs are in the forefront of artificial reef design, including preformed concrete modules thirty or forty feet high and weighing several tons and, more recently, special reef units made of fiberglass-reinforced plastic. While these reefs can be expensive, Japanese studies claim that they generally pay for themselves in increased catches and reduced fishing effort within about five years.

One reason for this difference between U.S. and Japanese reefs, however, stems from a different approach to fisheries management. Virtually all fisheries in the United States are considered a common property resource, that is, no one fisherman or group of fishermen have exclusive rights to any stocks of fish. In Japan, by contrast, many of the artificial reefs are paid for, at least in part, by commercial fishing cooperatives, which are then given by the government exclusive access to the new reef area.

In spite of these differences, however, U.S. artificial reef proponents continue to explore new materials and designs. Japanese reef units, made from fiberglass-reinforced plastic are being tested off Florida. And an innovative reef construction technique using blocks of stabilized coal combustion waste material was constructed off Long Island, N.Y., in 1980. The reef is still being monitored to determine its biological and environmental impacts. ■

Acid Rain

Measuring A Menace from the Skies

Bill Brennan

Sulfuric acid is a bad actor in any environment. It's the battery acid that eats through our clothes. It's the scarring vitriol thrown by jealous lovers in 19th century melodramas. It can etch metal, eat wood, corrode stone. It's close to the alchemic universal solvent. And we're leaking it slowly into our atmosphere from hundreds of sources—in small quantities and greatly diluted, to be sure, but still enough to cause concern.

For example, there is evidence that coal-burning industrial plants are creating dangerous amounts of gaseous sulfur dioxide which, joining with oxygen and moisture in the atmosphere, forms sulfuric acid. When this chemical compound falls from the sky as "acid rain" it can damage forests hundreds of miles downwind from its origin. And there may be other detrimental effects from such industrial pollution.

Acid rain is so diluted that it poses no physical danger to humans, but there is evidence that it may cause damage to woodlands hundreds of miles from the origins of the sulfurous discharges which contribute to its formation.

Can it be stopped?

Probably; but there are many questions to be answered before one can begin to assign responsibility. Where does the pollution come from? Who or what creates it, and how? Does some of the blame lie with Nature itself? What actually happens between the time pollutants leave a plant's chimney and the time they fall to the ground as acid rain. Can the path of dirty air be monitored accurately? Can it be predicted?

A massive, multi-million dollar research effort to provide an objective and comprehensive information base for use by decision-makers in setting a national policy on the sensitive issue of acid rain is moving into high gear, and NOAA's Environmental Research Laboratories (ERL) are playing a key role.

A Congressionally mandated 10-year program to find as many answers about acid rain as possible is beginning to flourish after having moved from the planning and organizational stage into one of producing results in more than 250 individual projects.

Nearly 10 percent of the projects have been assigned to ERL in three major areas of responsibility: investigation of the natural sources of chemicals contributing to acid rain; study of the movement of chemicals from both natural and man-made sources through the atmosphere; and establishment of an accurate system for monitoring the deposit of these chemicals upon the earth's surface.

While hardly new areas of activity for NOAA—both its Aeronomy and Air Resources Laboratories have been concerned about chemicals in the atmosphere and their dispersion for years—today the agency's acid rain initiatives are a matter of highest-level interest, as reflected by its role in the National Acid Precipitation Assessment Program.

NAPAP represents a coordinated, interagency effort to gather all possible facts about acid rain: where it comes from, where it's having its impact, how it gets there, how much its threat is increasing, and how to control it. The NOAA Administrator is one of three government officials sharing the chairmanship of this effort, while Air Resources Laboratory Director Lester Machta is one of three Deputy Joint Chairs who comprise the Program's Executive Committee, coordinating the work of a 20-member interagency task force.

Other government agencies—among them the Departments of Energy, Interior, Agriculture, and State, and the Environmental Protection Agency—also are involved, with assignments in such areas as man-made sources of acid rain, terrestrial effects, aquatic effects, control technologies, and the like.

The combined results of all the studies are expected to give a comprehensive picture of the acid rain situation in the United States, and provide national leaders the background they need to make informed decisions.

NOAA's work in natural sources of acid rain highlights a fact that has been somewhat obscured—nature herself is a contributor to the problem. Whether this contribution is a significant factor or only background noise remains to be seen, but the need to know is obvious: before policy-makers can decide—assuming they do—that man-made emissions must be reduced, they must have some idea of how much and what kinds of chemicals are drifting through the atmosphere, interacting with one another and causing unacceptable levels of acid rain, whatever the source.

Nature puts chemicals into the atmosphere in a variety of ways. Volcanic eruptions hurl huge amounts into the atmosphere, if only on a sporadic basis. Constantly, chemicals from rotting vegetation and animal life in the oceans and wetlands rise up across the ocean-atmosphere interface. Dust storms swirl into the skies, carrying chemicals with them.

Some of these compounds interact with other chemicals already in the atmosphere, creating sulfuric and nitric acid, the stuff of which most acid rain is made. Some are believed to have a neutralizing effect upon the "harmful" substances, while still other natural-source chemical compounds remain a mystery, requiring further study to determine their role.

Present thinking in the scientific community is that the quantity of compounds from natural sources of entering the atmosphere is too small to be of much significance in the creation of acid rain. Earlier studies by the Atlantic Oceanographic and Meteorological Laboratories in the Pacific, and the Air Resources Laboratory along the coast of the Gulf of Mexico, tend to support this. Certainly, the quantities of compounds measured at specific sites by these two elements of the Environmental Research Laboratories were modest. But the oceans and wetlands cover vast portions of the globe, and the total emission could be greater than anyone might think. Some earlier estimates of terrestrial sources of sulfur apparently underestimated the natural emissions, and the same could happen with estimates of oceans and wetland emissions.

This has to be nailed down. The benefits that might be anticipated from a controlled reduction of man-made emissions could be erroneously optimistic if natural sources do in fact make a significant contribution to total emissions.

Filling the gaps in knowledge about natural sources thus becomes of major importance. Additional studies must be done: at sea by researchers from AOML and the Pacific Marine Environmental Laboratory, and in the air and from the ground by ARL scientists. Equally important, the techniques used to estimate emissions must be fine-tuned for maximum accuracy, and instrumentation assembled to determine emissions from soil.

What happens to the compounds once they get into the atmosphere is the second major investigative area assigned to NOAA in the National Acid Precipitation Assessment Program, and here, too, earlier ERL research has been significant, showing that at least some of the sulfur dioxide and nitrogen oxides emitted flow out into the Atlantic and don't affect the United States.

ERL's Aeronomy Laboratory has built a strong research reputation with its atmospheric chemistry work. For example, for a number of years the laboratory has been analyzing data acquired from above several special research sites, to understand what causes sulfur dioxide and nitrogen oxide to be transformed into sulfuric and nitric acid, respectively. Already they have deduced how, through photochemical transformation, ozone is broken apart in the presence of water vapor to form the catalysts which react with nitrogen oxides to make nitric acid.

Even as they are being transformed, the chemical compounds also are being transported through the atmosphere, horizontally and vertically. Winds and air currents carry them through the skies, and they leave behind them, on the ground and in the waters under their flight path, "footprints" of their passage; fall-out deposition.

Earlier research has shown that acidic deposition can be either wet or dry. Wet deposition happens when the acid compounds are washed out of the sky by rain or snow. Dry deposition, ultimately perhaps just as harmful as wet but not as immediately recognizable, occurs when small particles of acidic materials impact upon the ground or vegetation by turbulent diffusion.

During the summer of 1983, the Air Resources Laboratory conducted the CAPTEX, or Cross-Appalachian Pollution Transport Experiment, to determine the flow of pollutants from sources in the Midwest and Ontario. In this study, a series of releases of a special tracer was made, and its movement and deposition monitored by seven aircraft and a network of 80 sampling stations fanning out to the Northeast from the Ohio Valley. While results are still preliminary, the study will provide new information on transport and deposition of pollutants, including those that result in acid rain.

CAPTEX is but one of numerous ERL pollutant-transport studies, some conducted as long ago as the late 1970s, which should contribute to its national investigation assignment.

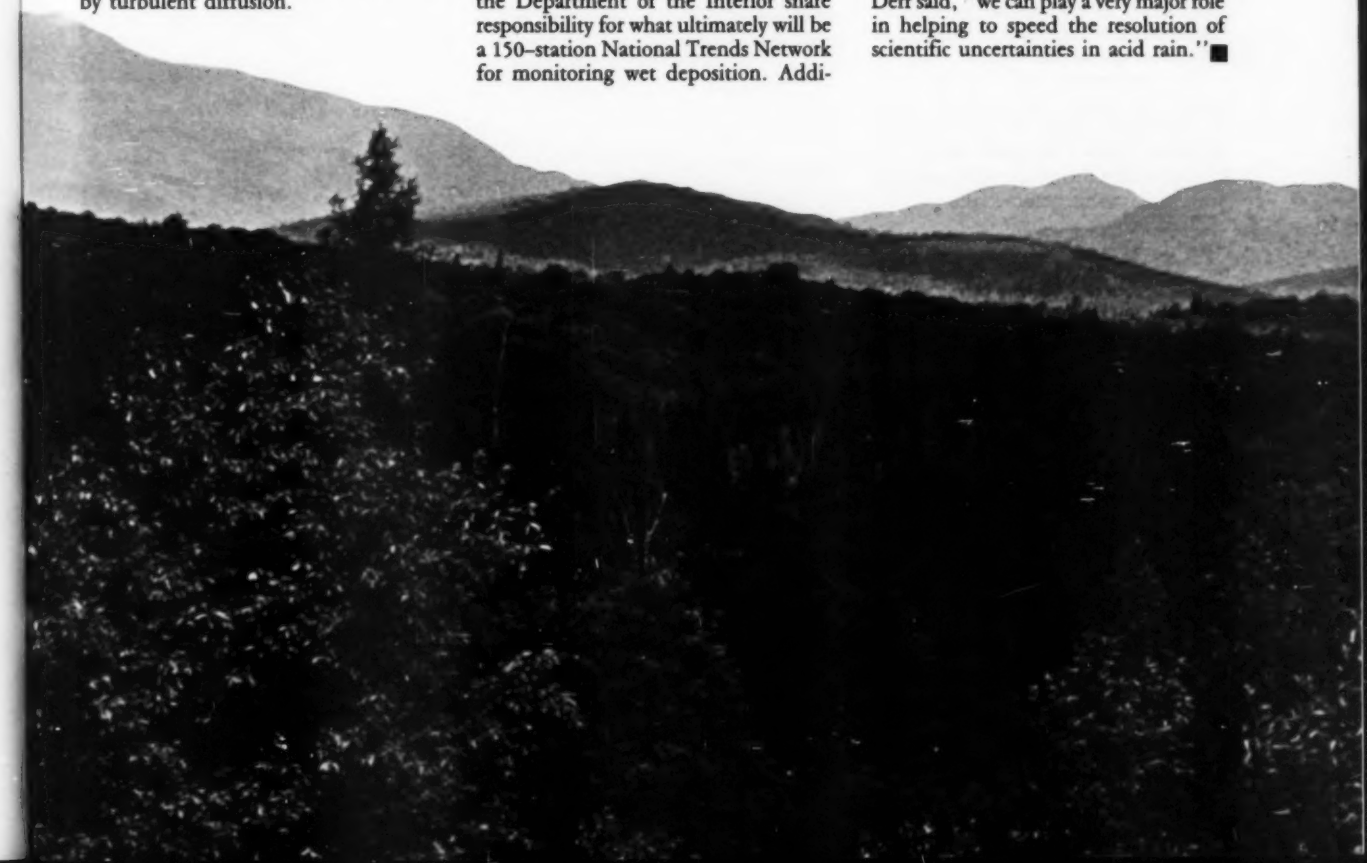
Monitoring of deposition—wet or dry—is key to the entire acid rain investigation. Monitoring will reveal the geographic extent and variability of the acid rain phenomenon. It will show how chemical loads from acid precipitation vary with time during the year and from year-to-year. It will verify—or reject—computer model projections of deposition resulting from implementation of pollution-control measures, should such measures be put into effect.

In the national program, NOAA and the Department of the Interior share responsibility for what ultimately will be a 150-station National Trends Network for monitoring wet deposition. Additionally, NOAA has been assigned the task of developing, with the cooperation of foreign countries, a Global Trends Network to monitor acid precipitation around the world.

While the monitoring of wet deposition appears well under way, dry deposition is another matter. For mainly technical reasons, the number of monitoring sites has until now been limited to a handful of prototype stations, there being no widely accepted method for monitoring dry deposition on a routine basis. Thus, efforts now have been turned to developing improved air concentration measurement devices, testing them in a prototype monitoring network, and analyzing the data provided.

NOAA, according to ERL Director Vernon E. Derr, is specially qualified to provide leadership in acid rain research. With neither regulatory responsibilities nor conflicts of interest, it is an "honest broker" which can be counted upon to provide unbiased assessments. Its high scientific standards have created respect among other agencies, environmentalists and industry. And in independent research in recent years, NOAA has already built a strong research base in many aspects of the acid rain issue.

"Given the proper resources," Dr. Derr said, "we can play a very major role in helping to speed the resolution of scientific uncertainties in acid rain." ■



An In Depth Study

In Pursuit of the Pollock

Lisa Loop

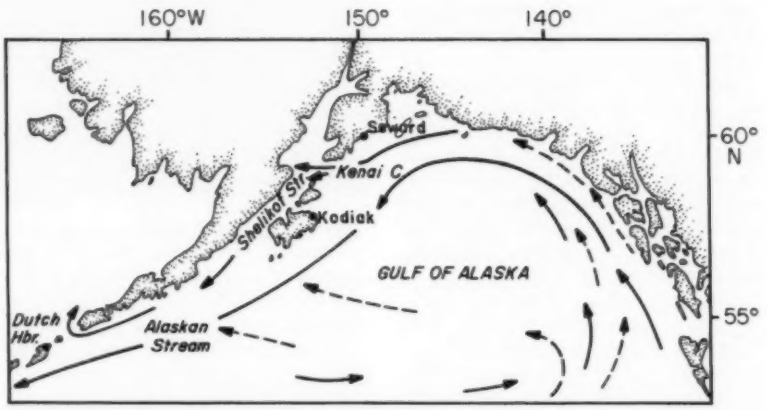
One day in 1980 an NOAA fishery survey in Alaska's Shelikof Strait happened on a huge concentration of life near the sea bottom, investigated, and discovered the biggest-known Pacific spawning ground for pollock. Nearly 20 by 40 miles long and meters thick, it held more than 3 million metric tons of fish.

This spring, the pollock patch will become the scene of a unique, and probably the largest, fisheries oceanographic experiment ever held in the Pacific Northwest. The Northwest-Gulf of Alaska Fishery Oceanography Experiment (FOX) will track the newly-hatched pollock, and the winds and currents that shape their young lives, for three months. Using ships, aircraft, and advanced sensors, scientists will seek to uncover the environmental factors that may mean the difference of millions of pounds in the annual catch.

The experiment will be precisely timed; the adult pollock come to their icy honeymoon hotel for just a month and then depart for parts unknown, leaving behind their eggs, which over the next 90 days will become fish.

The fate of these larvae is of real concern to the fishery industry; after menhaden, pollock is the most abundant of all commercial fish, and its catch, processing and sales constitute a big business. Pollock from the Pacific alone will be taken to the tune of nearly 3 billion pounds in 1985. Although it is not as familiar a supermarket item as, say, flounder or cod, it is purchased in huge quantities for fish sandwiches in fast-food restaurants, and is being used increasingly as the base for artificial crabmeat and similar delicacies.

Evidence of the importance of environmental conditions to the survival of young fish is plentiful: steady improvement in the Japanese sardine fishery in the early 1970s is attributed in Japan to a shift in the Kuroshio Current. And the fishery industry is still painfully aware of



This close-up of Kodiak Island was made by the Nimbus-7. The satellite's coastal zone color scanner, which senses radiation from the ocean's surface in six wavelength bands, indicates plankton concentrations and thermal patterns of value to FOX investigators.

NOAA's WP-3D aircraft will fly nine missions for FOX.

the devastation to fisheries along the Pacific Coast by El Nino, a widespread warming of the eastern Pacific.

As for Shelikof Strait, it is dominated by the Kenai Current, flowing southwestward along the Alaska Peninsula and mixing with waters from Lower Cook Inlet before entering the strait. Studies have linked abundant halibut stocks to the strength of the current, suggesting that its transport is related to survival.

Scientists from the Northwest and Alaska Fisheries Center and the Pacific Marine Environmental Laboratory will study the movement of the larvae as they are propelled slowly toward the open sea by the strait's currents. They suspect that newly-hatched pollock eggs stand a better chance to live if they remain in the shallow coastal area above the continental shelf; and, conversely, that being swept prematurely off the shelf will kill them in enormous numbers, reducing the stock by millions of tons.

"The early life stages are the time when there is the potential for creating really big or really small year classes (total numbers of a given population hatched in one year), because there are so many eggs and larvae that small differences in the average mortality rate can make huge differences," said Lewis Incze, a project oceanographer.

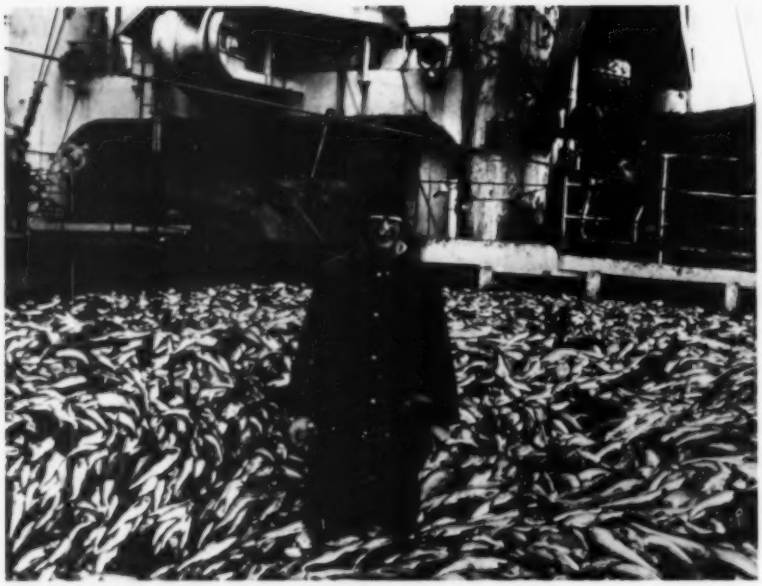
Many factors can affect the outcome, he explained; possibly the plankton on which new pollock feed are more abundant in the shallow waters close to shore; there may be fewer predators in the area. Winds, currents and temperatures will be closely monitored as NOAA analyzes the influences on the pollocks' lives.

James Schumacher, Pacific Marine Environmental Laboratory oceanographer, explains, "we want to look at the flow, the transport system—how it varies with the depth of the water column, distance from the coastline. We want to find out what the pattern is. Then we would have a good basis for understanding what would happen whenever there are extreme or extraordinary events." Though over fishing is a major cause of depleted stocks, Schumacher believes there are times when physics alone can dictate what will happen to a population.

Though the majority of FOX's research activities, nine plane flights and four major cruises, will take place in March, April and June of 1985, stationary instruments have already been deployed in nine locations in the strait. Equipped with pressure gauges and meters to measure current strength and direction, they will also provide data on temperature and salinity. In conjunction with other elements of the investigation, the information from these stationary instruments will give investigators valuable data about the link between wind patterns and water movement.

One of the best tools for observing spatial wind patterns is airborne measurements. Nine flights of the NOAA WP-3D aircraft will be conducted during FOX, allowing scientists to measure wind speed and direction in a variety of locations in a short time. Al Macklin, Pacific Marine Environmental Laboratory meteorologist, notes that the aircraft will provide information about the interaction of winds within the strait and how they affect the larval patch. A key factor influencing transport of the larvae are so-called gap winds, which blow at accelerated speeds down the narrow corridor between the Alaska Peninsula and Kodiak Island. Macklin points out that gap winds may be a principal means of transporting the larval patch offshore. "One of the things we will be

The NOAA Ships Discoverer (above) and Miller Freeman will take samples and make measurements during the Shelikof Strait FOX experiment.



Knee-deep in pollock, a NOAA observer (above) keeps track of activities on a Soviet joint-venture fishery vessel in the Gulf of Alaska. At right, pollock are hauled aboard a Japanese joint-venture ship. An estimated 3 billion pounds of pollock will be taken from the Pacific this year.

looking at is how long the gap winds last," he said. "The longer they last, the further the larvae will be transported."

Another element in the transport process is valley winds, which enter the strait from between the neighboring mountain peaks. As with gap winds, they may have a profound effect on the larvae but, according to Macklin, "we don't really know where or for how long they exist." An additional benefit of this knowledge of wind patterns will be increased accuracy of weather forecasts for the area; wind and superstructure icing make the strait extremely dangerous for fishermen.

The aircraft will collect surface and subsurface water temperature and water depth data with instruments that produce, what Pacific Marine Environmental Laboratory meteorologist Judith Wilson calls ". . . snapshots of the horizontal and vertical temperature structure in the Strait." The pictures set the scene, giving an overall survey of the temperature pattern, vertical structure, and a variety of other data. They provide a clear impact of the thickness of the boundary of warmer waters near the surface compared to the colder offshore waters. The varying depth of this warmer water is a direct indication of mixing due to wind and, with data from stationary instruments and ships, illustrates the immediate effects of weather on the environment in which the larvae develop.

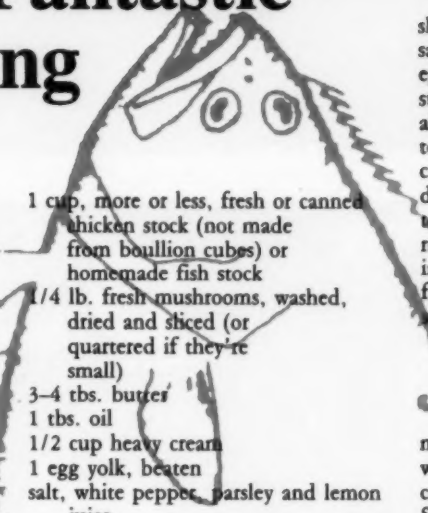
The NOAA ships Discoverer and Miller Freeman will participate in four cruises for water property and plankton sampling. They will conduct detailed temperature and salinity sampling, gathering data about water flow and mixing. Information about the plankton population, a factor which investigators believe to be related to the growth rate of pollock, will be collected using towed nets. Samples of fish will be preserved for future comparison to similar samples from the Bering Sea, where pollock spawn in larger numbers but usually in lower concentrations and seem to grow faster than those in the strait.

Ultimately, investigators hope FOX and experiments like it will provide NOAA with the means to make improved predictions of fishery population levels. In the view of Incze and Schumacher, FOX is just the beginning. The next logical step in being able to forecast population levels accurately, they say, would be to test for long-term variations of currents, weather patterns, rainfall, or any one of a variety of elements which could have an impact on the fishery.

"I would like to see a computer forecast model of this chunk of the Gulf developed, one that would rely on a few environmental parameters that could be remotely monitored," says Schumacher. The result could be a forecast of physical factors that managers could depend on to help set quotas and forewarn fishermen. "You could tell when to set quotas low, and maybe tell some of the fishermen to change their gear and go back to crab setups. Once you establish a good set of factors to look for, you would be able to predict a catastrophic event." Likewise, Schumacher added, the same model could be used to produce forecasts of especially strong year classes, so fishermen would be able to gear up for abundant harvests.

To this end, experiments are being considered to narrow the number of critical factors which could cause massive population fluctuations in the pollock fishery. Like FOX, they would require specialists in numerous disciplines to join forces to help assure that each year NOAA will be better able to monitor the health of the fishery and the security of the fishing industry. ■

For Flounder – Light and Fantastic – Try Poaching



Virtually every cooking method—baking, broiling, grilling, poaching, frying, steaming—can be used in preparing fish. Not surprisingly, however, certain methods lend themselves better to some varieties of fish than to others. Grilling or broiling, for example, are ideally suited to robust, firm-fleshed, oily fish like salmon or tuna. The same methods would not work so well with cod or haddock.

Poaching—cooking fish in a liquid barely at the simmer—is one method that is perfectly suited to fish that are delicate, both in taste and texture. Moreover, the liquid the fish is poached in can be used as the base for an almost endless variety of sautes that can heighten or contrast with the intrinsic delicacy of the fish itself.

The fillets of flounders and other small flatfishes like dab, sole and turbot, poach so beautifully and, when suitably sauced, can make such wonderful presentations, that it seems a pity that all we do with them most of the time is dredge them in flour or bread crumbs and then fry them.

The following recipes, which will serve six, call for your best white bordeaux. You can accompany the fish with rice or boiled potatoes and almost any green vegetable—buttered peas or green beans, for example, although you wouldn't want to repeat the spinach in the Flounder Florentine.

Basic Poached Flounder Fillets

3 lbs. fresh fillets of flounder or other flatfish (about 12 fillets)
1–2 tbs. finely minced shallot or green onion
1 3-inch piece carrot, scraped, and cut into jullienne strips, about 1½ inches long
1/2 cup dry white wine (or 1/3 cup dry vermouth)
1 cup, more or less, fresh or canned chicken stock (not made from boullion cubes) or homemade fish stock
1/4 lb. fresh mushrooms, washed, dried and sliced (or quartered if they're small)
3–4 tbs. butter
1 tbs. oil
1/2 cup heavy cream
1 egg yolk, beaten
salt, white pepper, parsley and lemon juice

Add about 2 tbs. of butter to an enameled or stainless ovenproof pan and saute the shallot and carrot for about two or three minutes over medium heat, until they become limp and the shallot loses its color. Remove the pan, with the carrot and shallot, from the heat. Roll the flounder fillets, skin side in (the skin side has a thin, smooth membrane and a slight grey cast to it), and arrange them in the pan, as close together as possible. The pan should be of a size to just hold all the rolled fillets. Add the wine (or vermouth) and enough stock to almost cover the fillets. Return the pan to high heat and bring the poaching liquid to the simmer. Cover the pan with a round of buttered wax paper—don't use aluminum foil, which will discolor the liquid—and place the pan in a preheated, 350° oven, regulating the oven temperature so that the poaching liquid is just simmering. Poach for about 10 to 12 minutes. The fish is done if it springs back when you press it gently with your finger. Don't overcook the fillets.

While the fish is poaching, saute the mushrooms for about 3 to 4 minutes in 2 tbs. butter and 1 tbs. oil. Set aside.

Carefully remove the fish fillets from their cooking pan and place them attractively on a serving platter. Cover them with the wax paper and keep them warm while you make the sauce.

Rapidly boil down the poaching liquid to about one cup, adding any liquid that may have drained from the fillets on their platter. Add the heavy cream and again boil rapidly for 2 or 3 minutes, thickening the sauce slightly.

Beat the egg yolk in a small bowl and slowly add about 1/2 cup of the hot sauce to the beaten egg yolk. Return the egg yolk mixture to the remaining sauce, stirring constantly over low heat for about 2 minutes, until the sauce begins to thicken to the consistency of heavy cream. Taste carefully for seasoning, adding salt, white pepper and lemon juice to taste. Just before serving, add the reserved mushrooms and reheat gently in the sauce. Pour the hot sauce over the fish, sprinkle with chopped parsley, and serve immediately.

Variation — Stuffed Fillets

To make the basic poached fillets even more elegant, you can stuff the fillets with about 6 to 8 oz. canned or leftover cooked crabmeat, lobster or shrimp. Saute chopped crab, lobster or shrimp in a little butter for a minute or two. Add 2 tbs. of cognac or dry sherry and boil down rapidly until all the liquid is evaporated. Spread about a tbs. of the mixture on the skin side of each fillet, roll them up jelly roll fashion, and proceed as in the basic recipe.

Variation — Flounder Florentine

Wash and trim about 1 lb. fresh spinach or Swiss chard. Cook in a large quantity of boiling salted water until just tender, about 4 minutes for the spinach, a little longer for the chard. Drain and cool under running water. A handful at a time, squeeze as much water as you can out of the greens and chop them into a fine mince. In an enameled or stainless steel pan, saute the greens in a tbs. or so of butter to drive off the remaining water. Add salt, pepper and a very small pinch of nutmeg. Stuff the fillets with this mixture and proceed as in the basic recipe.

Other Variations

Try substituting 1/2 cup blanched, slivered almonds for the mushrooms in any of the recipes. Or just before serving, you may want to sprinkle the sauced fish with about 1/4 cup freshly grated Swiss or Gruyere cheese. Run the fish under a preheated broiler for a minute or two, until the cheese begins to brown and bubble. ■

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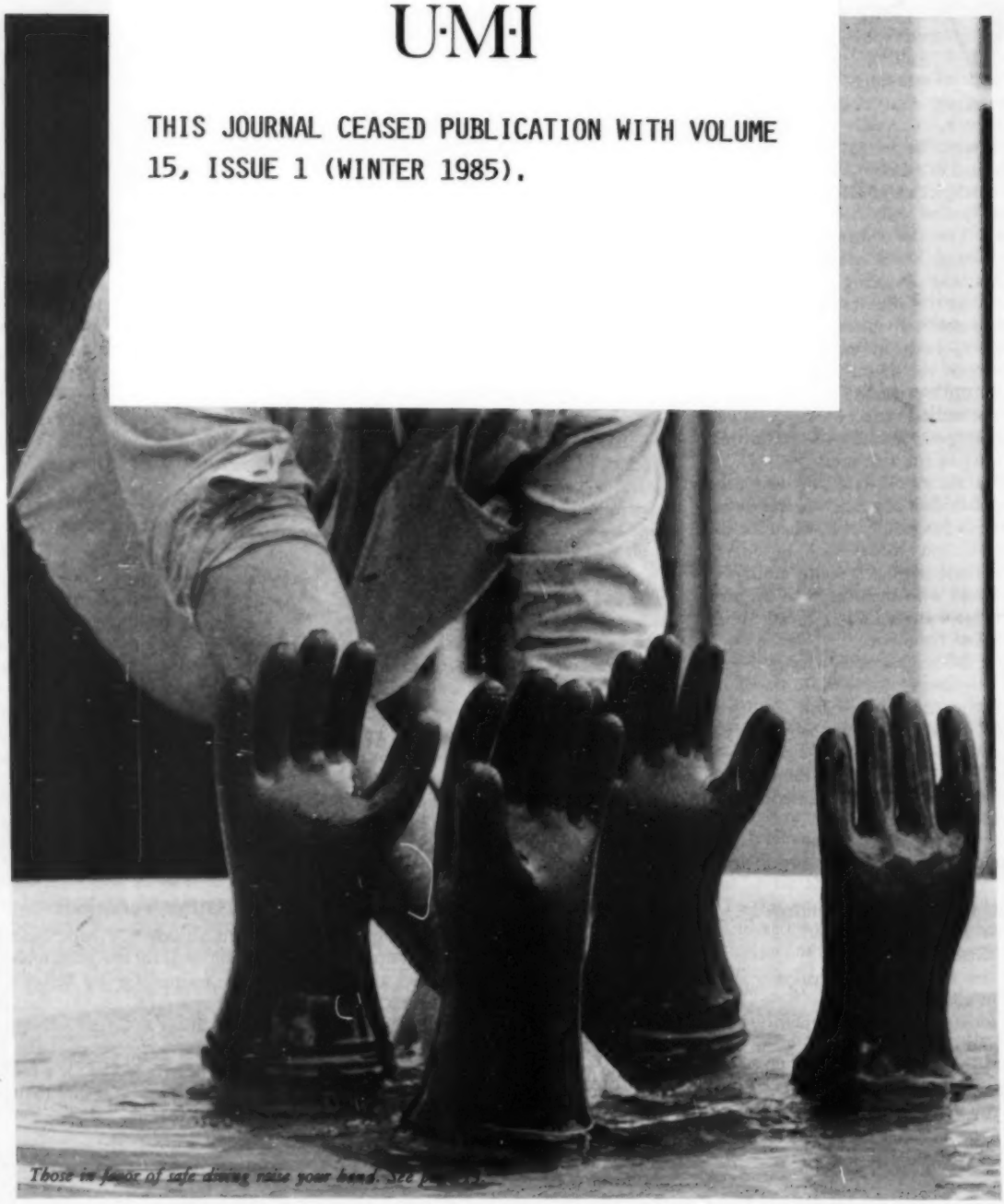
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